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environmental monitoring solutions

Aurora 1000

Single Wavelength Integrating Nephelometer

User Manual

Version: 1.3

www.ecotech.com

Manufacturers statement

Thank you for selecting the Aurora 1000 Integrated Nephelometer. The Aurora 1000 is a single-wavelength Nephelometer with innovative design features, designed primarily for visibility and particulate sampling. By following the guidelines contained in this manual and with the implementation of a good quality-assurance program, the user can obtain accurate and reliable data.

The Aurora 1000 is the next generation of sampler, it uses a single wavelength for visibility measurements at either of three wavelengths (450nm, 525nm or 635nm). The Aurora 1000 is a product of exceptional quality capable of producing years of maintenance free operation.

This User Manual provides a complete product description including operating instructions, calibration, and maintenance requirements for particulate sampling techniques.

Reference should also be made to the relevant standards, which should be used in conjunction with this manual. Some relevant standards are listed in the References section of this manual.

If, after reading this manual you have any questions or you are still unsure or unclear on any part of the Aurora 1000 then please do not hesitate to contact Ecotech.

Ecotech also welcomes any improvements that you feel would make this a more useable and helpful product then please send your suggestions to us here at Ecotech.

Please help the environment and recycle the pages of this manual when finished using it.

Notice

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Safety requirements

- To reduce the risk of personal injury caused by electrical shock, follow all safety notices and warnings in this documentation.

- If the equipment is used for purposes not specified by Ecotech, the protection provided by this equipment may be impaired.

- Replacement of any part should only be carried out by qualified personnel, only using parts specified by Ecotech. Always disconnect power source before removing or replacing any components.

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This product has been manufactured with care and attention.

The product is subject to a 12-month warranty on parts and labour. The warranty period commences when the product is shipped from the factory. Consumable items are not covered by this warranty.

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When you call please be prepared to provide the following information:

1. your name, telephone number and Facsimile number
2. Your company name
3. The model number or a description of each item
4. The serial number of each item, if applicable
5. A description of the problem or the reason you are returning the equipment (eg, sales return, warranty return, etc)

If you are required to return the equipment an accompanying document with:

1. Your name, number and Facsimile number
2. Your company name with return shipment
3. The model number or a description of each item
4. The serial number of each item, if applicable

A description of the problem/reason you are returning the equipment

Claims for Damaged Shipments and Shipping Discrepancies

Damaged shipments

1. Inspect all instruments thoroughly on receipt. Check materials in the container(s) against the enclosed packing list. If the contents are damaged and/or the instrument fails to operate properly, notify the carrier and Ecotech immediately.

2. The following documents are necessary to support claims:

    a. Original freight bill and bill lading
    b. Original invoice or photocopy of original invoice
    c. Copy of packing list
    d. Photographs of damaged equipment and container

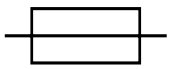
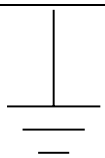
    You may want to keep a copy of these documents for your records also.

    Refer to the instrument name, model number, serial number, sales order number, and your purchase order number on all claims. Upon receipt of a claim, we will advice you of the disposition of your equipment for repair or replacement.

Shipping Discrepancies

Check all containers against the packing list immediately on receipt. If a shortage or other discrepancy is found, notify the carrier and Ecotech immediately. We will not be responsible for shortages against the packing list unless they are reported promptly.

Internationally recognised symbols used on Ecotech Equipment

	Electrical fuse	IEC 60417, No. 5016
	Earth (ground) terminal	IEC 417, No. 5017
	Equipotentiality	IEC 417, No. 5021
	Alternating current	IEC 417, No. 5032
	Caution, hot surface	IEC 417, No. 5041
	Caution, refer to accompanying documents	ISO 3864, No. B.3.1
	Caution, risk of electric shock	ISO 3864, No. B.3.6

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1 Introduction

1.1 Description

The Aurora will measure, continuously and in real-time, light scattering in a sample of ambient air due to the presence of particulate matter. (Specifically, the scattering coefficient $\sigma_{sp.}$) The measured values are adjusted automatically and in real-time by on-board temperature and pressure sensors.

Calibrations and zero / span checks are fully automatic, with checks initiated automatically, at user-selectable intervals. There is provision for several types of calibration gases.

A processor-controlled sample heater can eliminate the effects of relative humidity on scattering behaviour. The heater can be enabled and disabled by the user.

All these options are available from an easy-to-use menu system with a large 4-line backlit LCD display and keypad mounted on the instrument case.

Over 45 days' data can be stored in the internal data logger for later downloading through the RS-232 port. Instantaneous data can also be logged externally via the RS232 port or by using the four (4) real-time analogue outputs.

The Aurora also features low power consumption, very long-lasting and reliable LED's as the light source and has an exceptional signal-to-noise ratio.

1.2 Specifications

1.2.1 Measurement

Range:

- Measurement: <0.25 to 2000 Mm^{-1}.
- Light scattering angle: 10° – 170°
- Wavelength: 450nm, 525nm or 635nm

Lower detectable limit:

- < 0.3 Mm^{-1} over 60 seconds integration

Sample flow rate:

- 5 l/minute

1.2.2 Calibration

Calibration gases supported:

CO_2	SF6
FM-200	R-12
R 22	R-134

Automatic Calibration intervals:

3, 6, 12, 24 hours, weekly or user designated day

Automatic Calibration types:

Zero Check
Span Check
Zero and Span Check
Zero Adjust

1.2.3 Power

Operating voltage:

- 110-250VAC 50 or 60Hz
- 11-14VDC

Power consumption:

- 60VA max

1.2.4 Operating conditions

Ambient Temperature Range:

- 0-40°C

Relative Humidity

- 10-95%

1.2.5 Physical dimensions

Case dimensions:

- LxWxH = 175 x 700 x 235 mm (with feet)

Weight: 11.2kg

1.2.6 Communication and Data

Comm ports:

- 1 multidrop (RS232)
- 1 Serial port (RS232)

External I/O

- Analog 2 Voltage outputs
  2 Current outputs
- 2 digital inputs
- 1 digital output

Data properties

Averaging period: 1 or 5 minutes
Stored properties: σ_{sp}, Air Temperature, RH, Pressure, Enclosure Temperature, Time, Visibility
Capacity: 45 days (5 min)
10 days (1 min)

1.3 Nomenclature

Span
When gas of known Rayleigh factor is passed through instrument and measured as a reference. This measurement is used to correct measure coefficients.

Zero
When air with no particulate matter is passed through instrument and measured as a reference. This measurement is used to ascertain the effect of air (CO_2, CO etc) on scattering coefficient.

Shutter count
The shutter count is the measurement of light shone directly through a dark glass with known transmittance. This measurement is used as a reference for light intensity and PMT measurement.

Dark count
Measures background light scattering when light source is off (should be 0 but readings less than 200 are considered typical). Used to subtract from measure count to eliminate noise from background interference.

Measure count
Measures the light scattering of particulates in the sample air within the cell.

1.4 Background/ Theory

The effects of air pollution on human health and lifestyle are of a major concern today. There are many parameters contributing to air pollution, airborne particulates are a major contributor.

The Ecotech Aurora 1000 Integrating Nephelometer measures σ_{sp}, the scattering coefficient of light due to particles.
σ_{sp} may be used as a measure of particulate pollution, the higher the value of σ_{sp} the higher the concentration of particles. It may also be used as a measure of atmospheric visibility, the higher the value of σ_{sp} the lower the visibility.
The dimension of σ_{sp} are inverse length. The Aurora 1000 reports σ_{sp} in units of the inverse megametre (Mm^{-1}). Conversion factors are:
1 Mm^{-1} = 10^{-3} km^{-1} (inverse kilometres) = 10^{-6} m^{-1} (inverse metres).

1.4.1 Background

Extinction Coefficients σ_{ext}

Attenuation of light (that is, reduction in its intensity) is usually expressed using the **Beer-Lambert law**:

$$I = I_0 e^{-\sigma_{ext} x}$$

Equation 1 Beer-Lambert law

where:

I_0 = initial light intensity,
I = intensity after distance x,
x = distance,
σ_{ext} = the attenuation, or extinction coefficient.

(sometimes the symbol b is used instead of σ_{ext})

The relationship between extinction coefficient and visual range is expressed in **Koschmieder's Formula**.

$$\mathbf{Lv = 3.912 / \sigma_{ext}}$$

Equation 2 Koschmieder's Formula

where:

L_v = visual range,
σ_{ext} = extinction coefficient.

The larger σ_{ext}, the more rapidly the light is attenuated (ie reducing visibility).

Assumptions

Light may be attenuated either by scattering off objects or absorption by objects. Thus the extinction coefficient σ_{ext} may be broken down into a scattering coefficient σ_{scat} and an absorption coefficient σ_{abs}:

$$\mathbf{\sigma_{ext} = \sigma_{scat} + \sigma_{abs}.}$$

Equation 3 Light attenuation equation

For light attenuation in the atmosphere, the objects responsible can be either gas molecules or airborne particles. The scattering and absorption coefficients may therefore be further broken down into

$$\sigma_{scat} = \sigma_{sg} + \sigma_{sp}$$

Equation 4 Scattering Coefficient

and

$$\sigma_{abs} = \sigma_{ag} + \sigma_{ap},$$

Equation 5 Absorption Coefficient

where the subscripts denote:

s: scattering
a: absorption
g: due to gas molecules
p: due to particulate matter.

σ_{sp}, for example, is the extinction coefficient due to scattering from particulate matter. Scattering due to gas molecules (coefficient σ_{sg}) is also called 'Rayleigh scattering'.

NO_2 is the most significant gaseous absorber and soot the most significant particulate absorber. However, except in extremely high concentrations, the effects of absorption are negligible compared to the effects of scattering. Therefore, to a very good approximation,

$$\sigma_{ext} \approx \sigma_{scat} = \sigma_{sg} + \sigma_{sp}.$$

Equation 6 Relationship of Extinction coefficient with scattering Coefficient

It is σ_{scat} that the Aurora 1000 measures directly. When the instrument performs a zero adjust in particle-free air (that is, where only Rayleigh scattering is present), the σ_{sg} component of σ_{scat} is subtracted leaving σ_{sp} as the reported parameter.

Higher particulate concentrations mean more scattering, so σ_{sp} is a good measure of particulate pollution.

In urban situations σ_{sp} will be much greater than Rayleigh scattering (σ_{sg}). σ_{sp} is therefore also a good measure of atmospheric visibility.

Effects of Wavelength

Absorption and scattering are dependent on the wavelength of the incident light. In the Aurora 1000 either one of three different wavelengths can be chosen (450nm, 525nm or 635nm). Each wavelength interacts differently with particulate matter and thus differences in particulate composition can be inferred.

- 450nm (blue) interacts strongly with fine and ultrafine particulates (wood fires, automobiles)

- 525nm (green) interacts strongly throughout the human range of visibility (smog, fog, haze)
- 635nm (red) interacts strongly with large particulate matter (pollen, sea salt)

These different wavelengths overlap in measurements and do not directly measure differences in particulate composition, they merely infer differences.

Effects of Humidity

Above about 60% relative humidity, particles collect water droplets and grow because of the water vapour condensing on them, hence scattering more light.

The Aurora contains an internal heater which if enabled (section 3.5.5) heats the incoming sample when the relative humidity of the air sample rises above a threshold chosen by the user. This decreases the relative humidity and evaporates the water droplets.

Switching on the heater (dry measurement) would give a more reliable measure of airborne pollutant concentrations, as this evaporates (much of) the water droplets. Switching off the heater (wet measurement) would give a more reliable measure of local atmospheric visibility, because the sample inside the Nephelometer is then more representative of the particle sizes in the outside atmosphere.

Please consult your local Standards to determine whether the heater should be switched on for measurement of σ_{sp} and to determine what relative humidity limit should be used.

The Australian Standard, for example, requires the use of a heater to maintain the relative humidity at 60% or less (AS/NZS 3580.12.1:2001).

1.4.2 Measurement Theory

During normal operation three main measurements are undertaken. They are Shutter count, Dark count and Measure count.

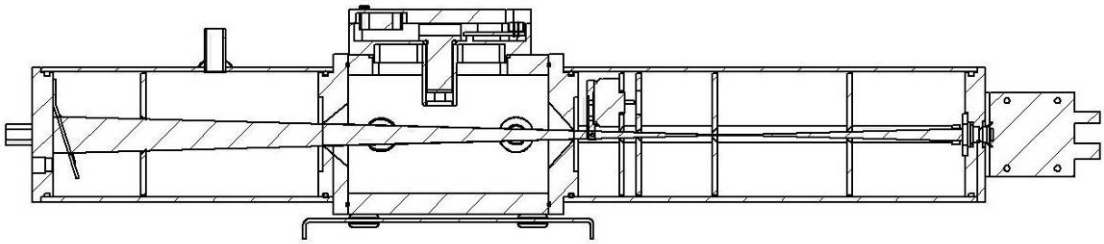


Figure 1 Light path layout

Shutter Count

Periodically (every 30 seconds) the shutter mounted inside the cell (see Figure 1), is closed for about 4 seconds. During this time, there is a direct light path from the Light Source, to the shutter and then to the photomultiplier tube. The shutter glass is a material with known transmittance that allows the Nephelometer to adjust for variations in the measuring system. This measurement does not rely on air scattering.

The results from the Shutter measure are stored as the Shutter Count and should be in the order of 0.8M to 1.6M.

Dark Count

The light source periodically flashes on and off in less than 1 second. When the light source is off, the PMT measures the Dark Count. That is, the background light incident upon the PMT when the light source is off. Ideally, this should be 0, however readings from 0 to 1000 are normal, as are fluctuations.

Measure Count

The measure count is taken when the shutter is open and the light source is on. The measured counts from the PMT are a result of scattering due to gaseous and particulate matter inside the measurement volume. As the concentration of scattering components inside the cell increases, so do the measure counts. Typical measure counts can vary from 5k to 500k.

Measure Ratio

The measure ratio (MR) is the ratio between the Measure count (C_m) and the shutter count (C_{sh}).

$MR = C_m / C_{sh}$

Eg. If C_m = 15,000 & C_{sh} = 1,200,000, then MR = 12.5×10^{-3}.

Because the C_{sh} is a known source, the MR is directly proportional to σ_{scat}.

If there are changes in the measurement system (ie. Light intensity or temperature), then both C_m & C_{sh} will change proportionally. Therefore the MR will remain constant. However if the σ_{scat} of the sample changes, then only the C_m will vary.

Kalman Filter

The Aurora 1000 has the option of using a fixed 30 second Moving Average Filter or the advanced digital Kalman filter (selectable from the Report Prefs menu).
The Kalman filter provides the best possible compromise between response time and noise reduction for the type of signal and noise present in the ambient air.
Ecotech's implementation of the Kalman filter enhances the Aurora 1000 measurement method by making the time constant variable, depending on the change rate of the measured value. If the signal rate is changing rapidly, the instrument is allowed to respond quickly. When the signal is steady, a longer integration time is used to reduce noise. The system continuously analyses the signal and uses the appropriate filtering time.

1.4.3 Calibration Theory

During a calibration, calibration gas and particle free air are passed through the cell at different times. Both these components have known values of σ_{sp} and σ_{sg}. When the measure ratio for these components are plotted against the known σ_{sp}, a linear relationship can be formed between σ_{sp} and Measure ratio.

Note: The effects of dark count and other variations measured through the shutter count, are compensated for in this relationship.

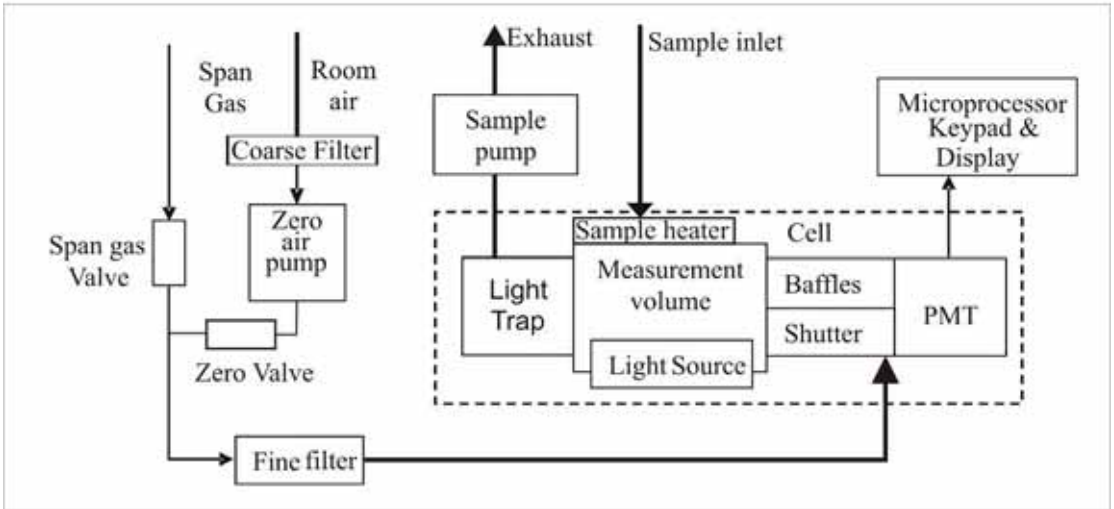


Figure 2 Block diagram

Zero calibrations are performed with zero air to subtract the Rayleigh scattering component) of σ_{scat}. Span calibrations are performed using certified gas, typically CO_2 or FM-200 gas (HFC-227ea Heptafluropropane).

Calibration Example

The following is an example of a typical calibration using CO_2 calibration gas with 525nm (green light source).

During a full calibration two points are measured.

- The span point is measured with CO_2 calibration gas.
- The Zero point is measured with particle free air.

During the calibration, the Aurora measures the C_m & C_{sh} as well as sample temperature (ST) and barometric pressure (BP). The following results are obtained.

Table 1 Calibration Data.

Point	Span	Zero
C_m (Hz)	13692	11582
C_{sh} (Hz)	1,200,000	1,200,000
MR (C_m/C_{sh})	11.41 x 10^{-3}	9.65 x 10^{-3}
ST (^oK)	300.2	300.2
BP (mBar)	1004	1004
σ_{scat} (10^{-6} m)*	24.79	0

At STP (273.15 ^{o}K, 1013.25mBar) and wavelength 525nm:

σ_{scat} for particle free air (Air Rayleigh) = 14.82 x 10^{-6} m.

σ_{scat} for CO_2 = 2.61 x 14.82 = 38.6802 x 10^{-6} m. (2.61 is the known multiplier of CO_2).

*Use STP normalisation to calculate the σ_{scat} at 300.2^{o}K & 1004mBar as measured in Table 1.

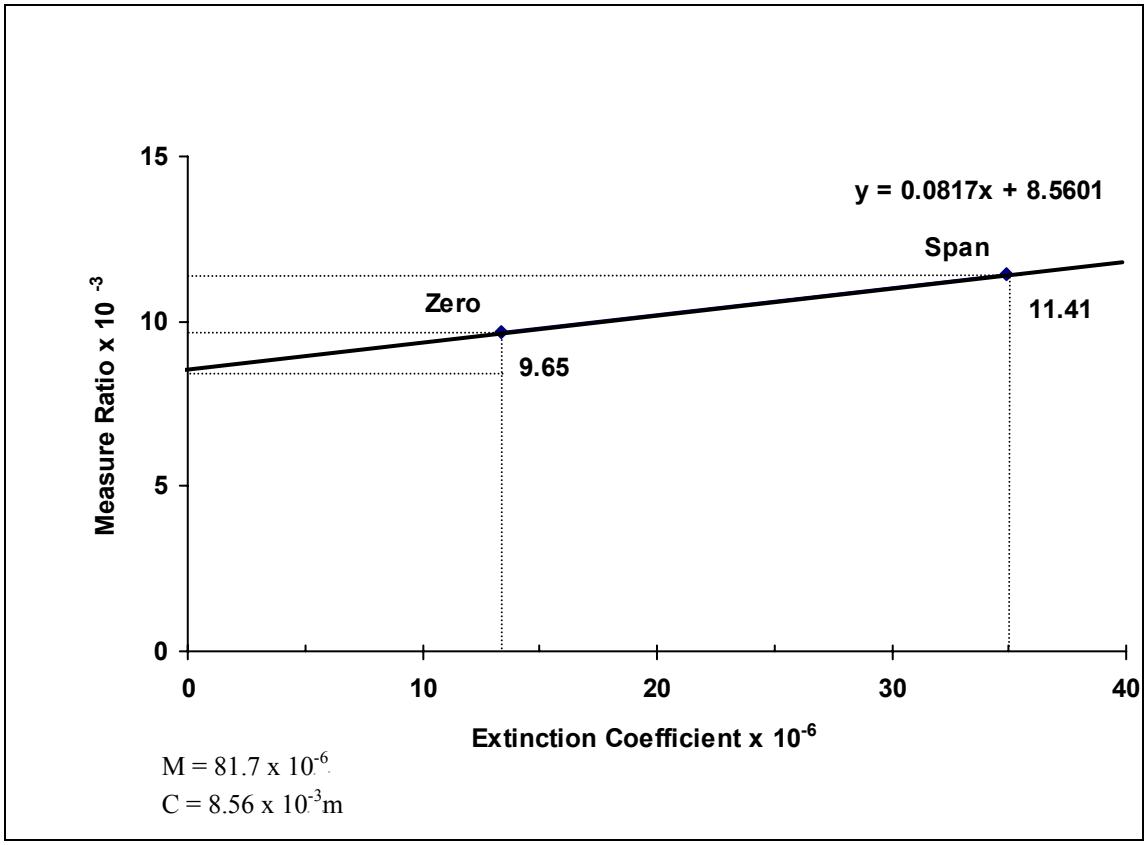


Figure 3 Aurora Calibration Curve

The values for σ_{scat} and MR are plotted on the above calibration curve. From this curve we can obtain a formula for converting the MR to σ_{scat}.

σ_{scat} = (MR - 8.56) / 0.0817 (10^{-3})

If for example our MR = 10 then,

σ_{scat} = 17.63 x 10^{-6}m.

In the Aurora 1000 all results are reported with Air Rayleigh subtracted.

σ_{sp} = σ_{scat} - σ_{sg} where σ_{sg} = 17.63 - 13.36 = 4.26 10^{-6}m.

Calibration Stability

When a full calibration is completed, the Aurora reports a value for Cal Stability. This is an indication of the variation of readings about the mean.
Given 150 samples, let x be the mean and s be the standard deviation.

Cal Stability = 100 * (1 - 2s/x) .

If Cal stability = 95%, then the standard error = 2.5%.

Typically during a calibration of either span or zero, a Cal stability of > 97% should be achieved.

Wall Signal

The Wall signal is the amount of scattering contributed as a result of internal reflections within the cell and foreign matter. The wall signal is calculated after a full calibration. Looking at the graph of figure 3 the wall signal can be calculated as follows:

Wall = 100x (C / $MR_{(ZERO)}$) = 100 x (8.56 / 9.65) = 88.7%.

Calibration Gas Constants

Table 2 lists the σ_{sp} for the supported calibration gases at different wavelengths and at STP.

The general formula to calculate the coefficient at a different wavelength:

$$\sigma_{sp}(\lambda_1) = \sigma_{sp}(\lambda_2)\left(\frac{\lambda_2}{\lambda_1}\right)^4$$

So for example:

$$\sigma_{sp}(450) = \sigma_{sp}(525)\left(\frac{525}{450}\right)^4$$

Wavelength (nm):	525	450	635
Air Rayleigh (10^{-6}m):	14.82	27.46	6.92
Temp (^{o}K):	273.15	273.15	273.15
Pressure (mBar):	1013.25	1013.25	1013.25

Note: the following table shows the Calibration Gas Constants used by the Aurora during a full calibration. The Aurora readings are with Air Rayleigh subtracted so that for clean particle free air (zero), the Aurora Nephelometer reads 0. All values are at STP.

Table 2 Properties of Calibration Gases at different wavelengths.

Gas Constants							
wavelength	Rayleigh air	CO_2	fm200	SF6	r12	r22	r134
		2.61	15.3	6.74	15.31	7.53	7.35
450	27.46	71.67	420.14	185.08	420.41	206.77	201.83
525	14.82	38.68	226.75	99.89	226.89	111.59	108.93
635	6.92	18.07	105.95	46.64	105.95	52.14	50.90
Aurora Readings							
wavelength		CO_2	fm200	SF6	r12	r22	r134
450		44.21	392.68	157.62	392.95	179.31	174.37
525		23.86	211.93	85.07	211.93	96.77	94.11
635		11.15	99.02	39.72	99.02	45.22	43.97

1.5 Instrument description

The Aurora 1000 measures σ_{sp} in the following way:

- Sample air is drawn through the sample inlet into the measurement volume and exits through the sample outlet via the pump.
- The light source illuminates the sample air in the measurement volume.
- Gaseous and particulate components of the sample air will cause the light to scatter.
- The baffles inside the cell are positioned so that only light scattered inside a narrow cone, at scattering angles between 10° and 170°, reaches the photomultiplier tube and so that multiple scattered light is unlikely to reach the photomultiplier tube.
- The photomultiplier tube produces electrical signals proportional to the intensity of the incident light. Hence the signal produced by the photomultiplier tube is proportional to the scattering coefficient of the sample air, σ_{scat}.
- The light trap and other baffles eliminate unwanted reflections from the light source and scattered light off the non-detecting end of the cell. The cell interior and baffles are coated with a special mat finish black paint to reduce any internal reflections.

After removing the front cover, you will see the Aurora's components. The following is a brief description of each of these components.

Figure 4 Aurora 1000 (with cover removed)

1.5.1 Cell

The cell is the critical part of the Aurora. It is within cell that the optics, the electronics and the pneumatics all come together. The cell pneumatically and optically sealed to prevent stray light and air from entering. It is made of black anodised aluminium with a coating of matt black paint on the inside to reduce internal wall scatter.

Figure 5 Cell

1.5.2 PMT

The PMT (Photo Multiplier Tube) is used to measure the light (photons) resulting from scattering. It is actually a photon counting head and produces an electrical signal (frequency) proportional to the incident light. The output frequency of the PMT ranges from 0 Hz to 1,600,000 Hz. The High voltage supply to operate the PMT is internally generated within the PMT. There is a black rubber cover over the PMT to reduce stray light from increasing the dark counts.

Figure 6 PMT

1.5.3 Shutter

The shutter is used to periodically check the operation of the Aurora as well as compensates for any variations in the measuring system. i.e. variations in light source intensity, or wall scatter. The shutter composes a solenoid and a piece of glass with known transmittance. It is mounted on a rotary solenoid and is switched in and out of the optical path. Typically when the shutter is switched in it will give a shutter count of around 0.8M-1.6M (though this number can vary depending on PMT sensitivity and light source intensity).

Figure 7 Shutter

1.5.4 Light Source

The light source uses high powered LEDs (Light Emitting Diodes) of a specific wavelength (450nm, 525nm or 635nm). LEDs are used instead of the conventional flash lamps because of much better reliability, stability and lower heating of the sample. Integration can also be performed over a longer period of time because LEDs can be turned on for longer.
The LED's are housed in a black assembly which can be easily removed for cleaning purposes. On the front of the Light Source housing there is an opal glass diffuser.

Figure 8 Light source

The opal glass diffuser ensures that the LEDs produce light with a lambertian distribution.

1.5.5 Sample Pump

The sample pump is the means by which large volumes of ambient air is drawn in through the sample inlet, through the cell and out the exhaust. This pump runs continuously drawing 5 l/min except during calibration and start up.

Figure 9 Sample pump

1.5.6 Zero Pump

The Zero air pump is a +12V DC diaphragm pump which draws air through the fine filter providing particle free air (zero calibration or zero check). It is not on during normal measuring mode. The zero pump has a DFU filter on its inlet to protect the pump from dust build up.

Figure 10 Zero pump

1.5.7 Zero/Span Fine Filter

The zero filter works in conjunction with the zero pump to provide the particle free air during zero calibration and zero check. Its filtration efficiency is greater than 99.5% removing particles greater than 0.1 micron in size.

Figure 11 Zero Filter

1.5.8 Span & Zero Valve

The span valve and Zero valve are +12V solenoid valve which are opened during a span calibration/span check or zero calibration respectively. When opened, it allows the calibration gas/zero air to pass into the cell for calibration.

Figure 12 Span and Zero valve

1.5.9 Temperature / RH Sensor

The Temperature and RH sensor are mounted on top of the cell measuring directly in the cell. The temperature and RH sensor are monitored by the microprocessor and their data recorded in the internal data logger.

- The Temperature/RH sensor measures the sample air temperature and is used in the compensation of σ_{sp} for STP (Standard Temperature and Pressure).
- The Temperature/RH sensor measures the Temperature of the sample air. This data is used to control the sample heater, hence controlling the sample temperature up to the desired set point.
- The Temperature/RH sensor measures the RH of the sample air. This data is used to control the sample heater, hence controlling the RH of the sample air down to the desired set point.

Figure 13 Temperature/RH sensor

1.5.10 Pressure Sensor

The air pressure sensor is mounted on the microprocessor board. It is connected pneumatically to the cell to measure the cell pressure. The measured pressure is used to convert the σ_{sp} to Standard Temperature and Pressure. The pressure is also logged internally on the data logger. The pressure sensor also is used to calculate the scattering coefficient of the calibration gas during calibration.

Figure 14 Pressure sensor

1.5.11 Sample Heater

The sample heater (when enabled), controls the body temperature of the cell. The cell temperature sensor is mounted in the cell wall (near the light source). The microprocessor controls the sample heater so that the sample air in the cell is kept at the desired set point for Temp or RH.

Figure 15 Cell Heater

- If the Aurora is installed in a room where the sample inlet is taking in outside air and the room temperature is much cooler than the ambient temperature, then the sample heater should be set to the temperature of average ambient temperature (25-30^{o}C).
- If the Aurora is running from batteries (+12v Option) then the sample heater should be disabled (it will reduce battery life significantly).

1.5.12 Microprocessor

The microprocessor board is the heart of the Aurora. It takes the raw count data from the PMT and converts them to real σ_{sp} values. It controls all the pumps, solenoids and light source. It internally logs the data and provides RS232 data and remote control capabilities. It also controls the LCD display and keypad allowing the user to view and modify parameters. The firmware (program) loaded on the microprocessor board is stored in EEPROM and can be upgraded via the serial port. It also contains a real time clock for data logging and auto calibration control. The calibration parameters and user settings are also stored in EEPROM, so they are not lost during a power failure.

Figure 16 Microprocessor board

1.5.13 Keypad & Display

The Keypad & Display provide the user with an interface so that they can input and retrieve vital operational data. The membrane Keypad comprises of 6 keys for easy access to the menu system. The display comprises of a backlit 4 x 16 character LCD displays for displaying data clearly. See section 3.2.1 for more details.

Figure 17 Keypad and Display

1.5.14 Backup Battery

The backup batteries are located next to the microprocessor board. They provide power to the real time clock and logged data when the Aurora is turned off.

> **Note:** if you disconnect the battery while the power is off, the clock settings and all logged data will be lost. However calibration and setup parameters will not be lost. The batteries are two AA 1.5V alkaline cells.

1.5.15 Electrical Connections

The following connections are found on the right side of the instrument (when looking at the screen). The placement of these electrical and communication connections is designed to minimise any interference from liquid spills or dust build up.

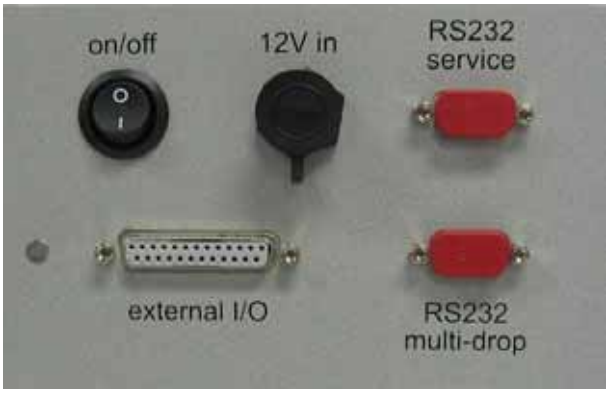


Figure 18 Electrical connections to the Aurora 1000

RS232

There are two RS232 serial ports available on the Aurora 1000, the multi-drop and service ports. The Multi-drop serial port is used for communication and data download, they can be connected to data logger or in a daisy chain configuration. The service port is used for diagnostic purposes. Refer to section 4.5.1 for further details on setting up the RS232 ports.

External I/O
The External I/O port is used to connect the analog outputs as well as external span and Zero controls. Refer to section 2.2.3 for further details.

12V in
The12V inlet is where the 12V power pack is connected. This supplies the power for the instrument which will not operate if not plugged in. The Power switch is located on the left side of the connector and must also be turned on (switched down) for the instrument to work.

1.5.16 Pneumatic inlets
The pneumatic inlet connections for the Aurora are located on the top of the instrument case (when looking at screen) so that inlet tubing can be positioned directly above the case and to the external environment (if necessary).

Figure 19 Pneumatic connections to the Aurora 1000

Sample
The ½" port labelled "sample", is where the sample inlet is connected. During transport or storage, this port should be closed to avoid debris from falling into the cell.

Zero
The Aurora has its own internal filters for generating particle free air. There is no need for any further connections on the "zero gas" port.

Span
The calibration gas used for calibrating the Aurora is connected here as discussed in section 2.2.1.

Warning: DO NOT leave FM200 gas connected to the Aurora for long periods of time as this may cause condensation and damage to the calibration control kit.

Exhaust
The Exhaust is located at the top of the instrument to the right side of the other pneumatic connections. The exhaust is pumped up through this outlet which has the ability to be vented out with a screw in exhaust hose (optional)

Note: During normal operation make sure that the exhaust is not covered.

2 Installation

The correct installation of the Aurora is very important to ensure that the instrument operates correctly and gives you reliable data. Please read the following sections carefully.

2.1 Initial check

Packaging

The packaging which the Aurora 1000 is transported in is specifically designed to minimise the effects of shock and vibration during transportation. Ecotech recommends that the packaging be kept if there is a likelihood that the instrument is going to be relocated.
Remove all packaging including red caps from instrument and store in a secure area. In the event that the packaging is to be disposed of, all the materials used are recyclable and should be disposed of accordingly.

Items Received

With the delivery of the Aurora 1000, you should have received the following:

• Ecotech Aurora 1000 instrument		PN: E01000X*
• Power cord		PN: ----------
• Serial cable		PN: C020016
• Manual		PN: M010001
• Software Utilities CD.		PN: COM-1018
• Leak test filter		PN: ZRU-57002758
• Rain cap with insect screen	(optional)	PN: EC0-M9003011
• Inlet tube (0.8m, 1m, 1.5m, or 2m)	(optional)	PN: H02032X*
• Wall mounting bracket	(optional)	PN: H020005
• Roof Flange	(optional)	PN: ECO-M9003004
• Calibration Kit	(optional)	PN: H020331
• Service Kit	(optional)	PN: H020335
• Exhaust tube kit	(optional)	PN: H020335

* X denotes either 1 (Green), 2 (Red) or 3 (Blue) for instrument or 0 (800ml insulated), 2 (1m un-insulated), 3 (1.5m un-insulated) or 4 (2m uninsulated) for sample inlet tube.

Please check that all these items have been delivered undamaged. If there is any item damaged or if you are unsure, please contact your supplier BEFORE turning on the instrument.

2.2 Assembly

2.2.1 Connecting the Calibration Gas

- Consult your local regulations for the positioning of the gas cylinder.
- In most cases the gas cylinders should be located outside the building and secured to a solid wall.
- The Calibration gas should be high purity 100% gas for accurate calibration.
- The calibration gas cylinder should be fitted with a regulator and flow meter.
- It should also include at least 1 metre coiled metal line to bring gas temperature to room temperature, especially if a refrigerant gas is used.

Ecotech can supply an optional Calibration kit (H020331) which provides all the necessary connections to connect the gas cylinder to the Aurora. The recommended gas delivery system is shown in Figure 20.

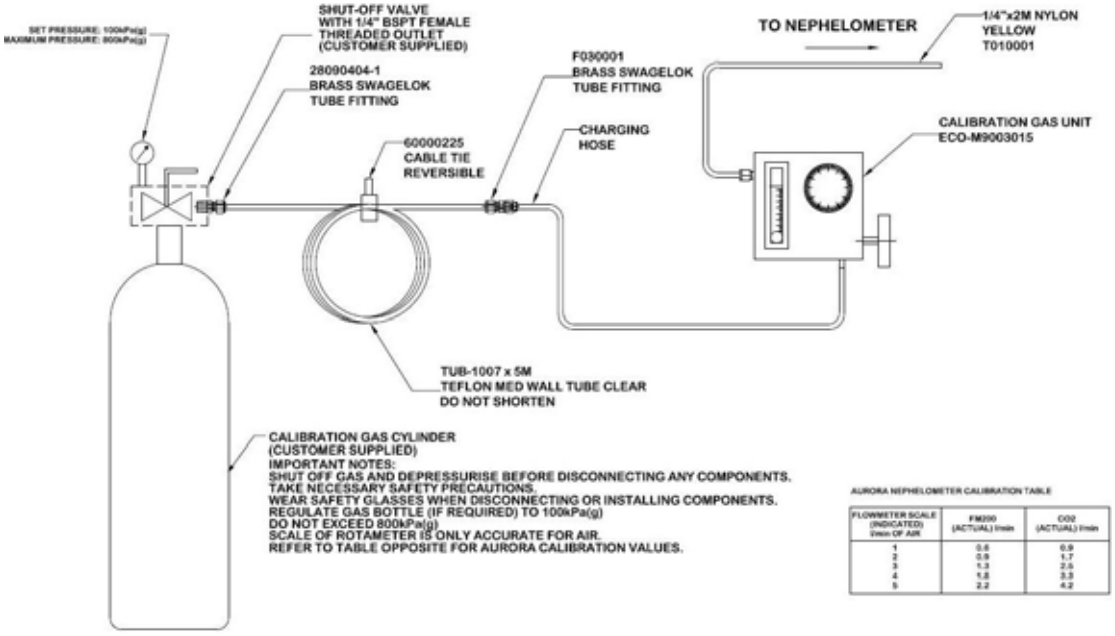


Figure 20 Span gas plumbing installation

Connect your calibration gas to the “span gas” port on the side of the Aurora. No connection is required for the Zero Air as the Aurora has its own internal filters.

2.2.2 Connecting the Power

The Aurora has an external, auto ranging power supply (100 to 250V AC, 50 or 60 Hz). This means that the Aurora can be connected to any domestic mains supply anywhere in the world via a standard IEC connector for the mains.

- The power cord should be connected to a general purpose power outlet.
- The outlet should have an earth pin for safety.
- The output of the power supply is 12v DC. The power supply has a 4 pin connector to connect to the 12v in connector on the Aurora.
- The on/off switch when pressed down will turn the instrument on.
- There is a green indicator of the Power supply to show if the main is on or not.

2.2.3 External Cable Connections

Although the Aurora has its own internal data logging feature, some situations may require it to be connected to an external data logger. There are two ways to connect to a data logger.

RS232

Ecotech supply an RS232 cable with each Aurora instrument. This cable is suitable for connecting directly from the Aurora (Multi-drop port) to a standard 9 pin RS232 port found on most personal or laptop computers.

If you require a longer cable for your application, the following diagram shows how it can be made.

> **Note:** When using cable lengths in excess of about 5 meters, you may need to reduce the Baud rate in order to reduce communication errors.

Section 5 contains more information on setting up the RS232 communications for data logger.

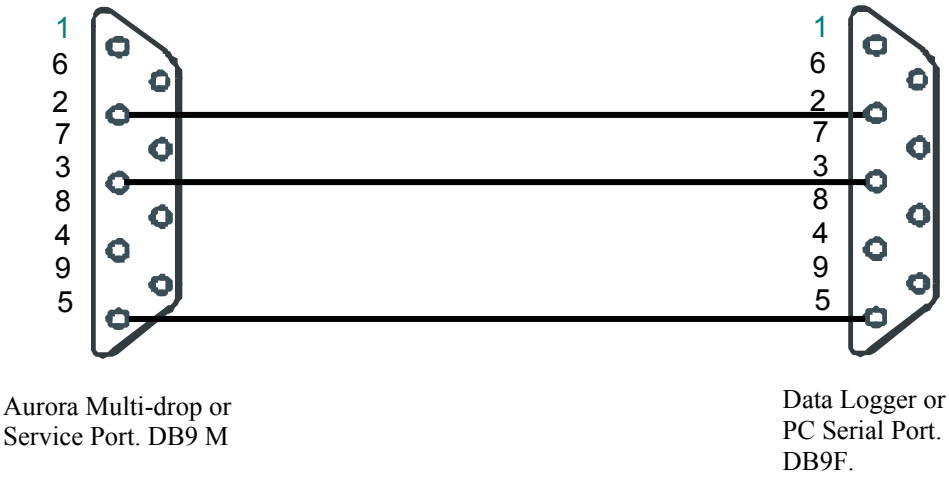


Figure 21 Aurora Service & Multi-drop Serial Port Cable

Table 3 RS232 pins and their functions

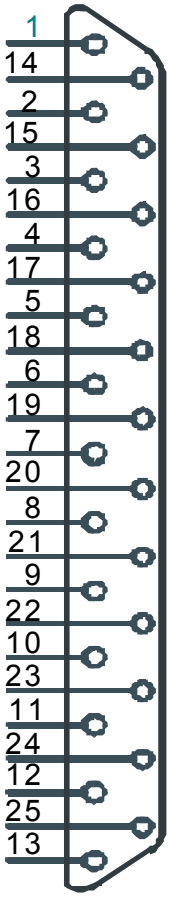
Pin No	Function
1	CD (not used)
6	DSR (not used)
2	RD
7	RTS (not used)
3	TD
8	CTS (not used)
4	DTR (not used)
9	
5	GND
Shell	Chassis GND

External I/O.

The Aurora has 4 analog outputs for connecting to data loggers or chart recorders, which do not support RS232 communications. The External I/O connector has the following connections:

- 2 voltage outputs (0 to 5V) Vout1 & Vout2, as well as 2 current outputs (0 to 20mA or 4-20mA) Iout1 & Iout2.
- DOSPAN & DOZERO (contact closure inputs / open collector) for putting the instrument into SPAN or ZERO measure (not calibration).
- +12V & +5V power supplies.
- Digital Analog & Chassis Grounds.

Table 4 Aurora 1000 External I/O connector



Pin No	Function
1	Chassis GND
14	Analog GND
2	Voltage OUT 1
15	Analog GND
3	Voltage OUT 2
16	Analog GND
4	Current OUT 1
17	Analog GND
5	Current OUT 2
18	Analog GND
6	
19	Digital GND
7	DOZERO
20	Digital GND
8	DOSPAN
21	Digital GND
9	+5V
22	Digital GND
10	Digital OUT
23	Digital GND
11	
24	Digital GND
12	+12V
25	+12V
13	Digital GND
Shell	Chassis GND

For further details in setting up the analog outputs refer to section 0.

2.3 Mounting/Siting

Siting Considerations

For additional information regarding siting, please consult your local Standards for siting guidelines.

The Australian Standard AS2922 requires that the sampling inlet be positioned:

- Between 2 and 5 metres above ground
- At least one horizontal metre and one vertical metre from supporting structures or walls
- With 120° of clear sky above the sampling inlet
- With an unrestricted airflow of 270° around the inlet, or 180° if the inlet is on the side of a building
- 20 metres from trees
- With no boiler or incinerator flues nearby

Mounting the Aurora

Note: The Aurora must be mounted so that the shortest possible length of tubing is used from instrument inlet to sample. This tubing should be vertical from instrument inlet straight up to sample i.e. no 90 degree kinks or horizontal sections as shown below.

Figure 22 Correct sample inlet connection

There are a number of ways in which the Aurora can be mounted. It can be seated on a bench top with the sample inlet running vertically through the roof, or mounted on a wall with the sample inlet running through the roof. An optional wall mounting bracket is supplied for easy mounting on the wall.
Attach the wall mounting bracket as follows:

- Determine where the Aurora is to be located and draw the centre line on the wall. This determines the positions of the sample and calibration gas inlets. Extend this line to the roof.
- Make sure there are no beams obstructing the inlets path through the roof.
- Mark and drill the holes for the wall mounting bracket.
- Secure the wall mounting bracket to the wall using two suitable fasteners. The bracket has two 7mm holes on its centre line to that effect. The two tabs should be at the bottom.

- Mark the position of the hole for the sample inlet tube and drill.
- The roof flange option can be used on the top of the roof to seal the sample inlet.

Note: When drilling holes, be sure to cover all open ports on the Aurora and supplied tubing. This will reduce cell contamination.

2.4 Instrument setup

When setting up the Aurora the following points should completed:

- Clear data logger (section 3.5.10)
- Set correct time (section 3.5.9)
- Set standard temperature (section 3.5.6 “Normalise to”)
- Set filter (Kalman or Moving average) section 3.5.6.
- Set automatic calibration interval (section 3.5.4.2 “Autocal intv”)
- Set Calibration gas type (section 3.5.4.2 “span gas” and/or “custom span gas”)
- Perform calibration (section 4.2)

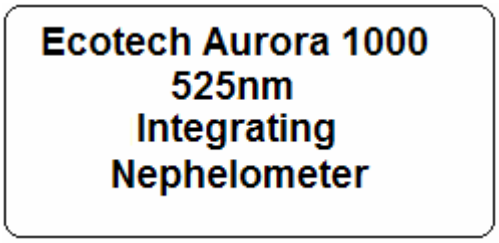
3 Operation

With the Aurora 1000 installed correctly as outlined in the previous sections, it is now ready to be used. This section will discuss what to expect and how to configure the Aurora once it is powered up.

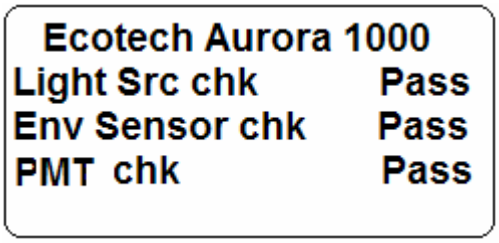
3.1 Startup

When the power switch shown in Figure 18 is switched to the ON position, the Aurora will go through its start up sequence as follows:

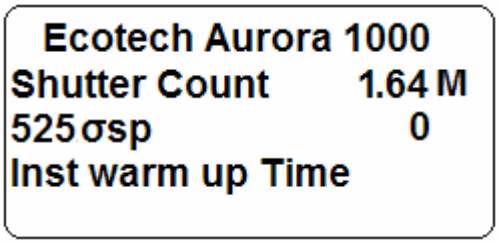
Welcome screen
- The shutter solenoid will periodically click in and out of position every 30 seconds.
- The display backlight will light up.
- The Welcome screen will provide information about the Aurora and its wavelength.



Instrument check
- The instrument runs through a diagnostic check of its systems checking the light sources, environmental sensors and photomultiplier. If any of these components fails the test it will be displayed with a fail on the right side of the instrument.



Warm-up
- The system calibration will commence.
- The instrument begins calibrating the shutter count, and sampling air (displayed on screen).



Main screen
- After the system calibration is completed, the sample pump will start up.
- The screen will now enter the main screen
- The Aurora is now in MONITOR STATE and is sampling as described in section 3.3.

*Light source chk will normally show a fail for the first 10 seconds, this is performed on purpose to ensure that no measurements are taken during instrument check.

3.2 General operational information

3.2.1 Display panel and Keypad

The display panel and keypad (Figure 22) allows all current measurements to be displayed, settings to be entered and commands given. It consists of a 4 line LCD screen with 6 general use command keys/buttons.

Figure 23 Display panel and keypad

Up arrow key **(⮝)**	Moves the cursor to the previous menu item or, in an input field, moves the cursor to the previous choice or increments the digit in a numerical field.
Down arrow key **(⮟)**	Moves the cursor to the next menu item or, in an input field, moves the cursor to the next choice or decrements the digit in a numerical field.
Select	Selects the menu choice or selects the field for input.
Pg Up	Moves the cursor to the previous page or screen.
Exit	Leaves a field without making a change or returns the cursor to the main screen.
Enter	Confirms a menu item or a field selection to the microprocessor.

Note:

- Only four lines may be displayed at a time. To reach options not on the screen use the up and down arrow.
- Units displayed on screen are set within the “report prefs” submenu (section 3.5.6) with the exception of σ_{sp}, which always has units of Mm^{-1} (inverse megametres) and relative humidity, always in %.

3.2.2 Display Backlight

When the Aurora is initially turned on, the Backlight on the LCD display will also turn on. However if the keypad is not used for approximately 3 minutes, then the Backlight will turn off automatically. The Display Backlight can be re-activated by pressing any one of the keys on the keypad.

3.2.3 Display Adjustment

On power up. the display contrast will maintain the setting from its previous operation. The contrast can be adjusted by pressing either the up or down arrows on the keypad when on the main screen.

3.2.4 Navigating the menu system:

- Press the up arrow and down arrow to move the cursor amongst menu options.
- Press Select or Enter to activate a submenu or to perform an operation (these menu entries usually have → after them to indicate their type), or to edit a parameter. If the parameter is not editable then pressing Select or Enter will have no effect.
- Press Page up to return to the next highest level menu.
- Press Exit to return to the Information Screen.

3.2.5 Editing parameters:

- Press the up arrow and down arrow to cycle among the options for that parameter.
- Numerical parameters are usually entered digit by digit. Press the up arrow and down arrow to cycle among the options for that digit (including the decimal point). Press Select to move to the next digit to the right or Page up to move to the next digit to the left.
- Press Enter to save changes to the parameter.
- Press Exit to cancel changes to the parameter.

3.2.6 Obtaining readings

- The Instrument readings may be obtained through any of the following methods:
- Display panel (see section 3.2.1).
- Internal Data Logging (see section 5.1).
- Serial RS232 Communication Ports (see section 5.3).
- Analogue outputs (see section 5.4).

3.3 Main screen

The main screen is displayed after the Aurora has passed through its warm-up or after pressing Exit while navigating the menu system. This screen is divided into three sections.

- The first line shows the Aurora's wavelength and the σ_{sp} current reading (updated each second).
- The second line is the current system state line which will display information about the instruments performance including warnings of any faults within the instrument.
- The last two lines display the current sample temperature (ST°C), Relative Humidity (RH%) and Barometric Pressure (BP). The value of each of these parameters is displayed immediately below on the forth line.

The Third line alternates after 16 seconds from the parameter names to the date and time. The date and time are only shown for 6 seconds.

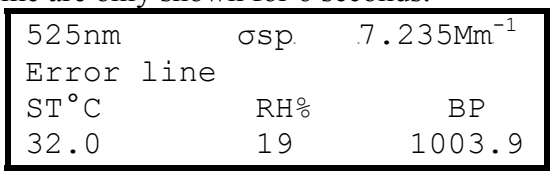


Figure 24 Main screen

3.4 Sampling

The Aurora 1000 performs continuous real-time sampling. The Aurora will provide updated measurements over the sampling time period chosen by the user (section 3.5.10 "Log period").

The units logger are:

σ_{sp}:	Scattering coefficient (0 to 2000Mm^{-1} or user defined full scale).
ST:	Sample air temperature in the cell (-40°C to 60°C).
ET:	Temperature within the Enclosure (-40°C to 60°C).
RH:	Sample air relative humidity (0% to 100%).
BPs:	Barometric pressure in the cell (150 to 1150 mbar).
Zero:	Outputs baseline signal; for example, a nominal 0V for a voltage port.
Full:	Outputs full-scale signal; for example, a nominal 5V for a voltage port.
Visibility	Measurement of visibility in units of metres.
σ_{sp} 5m:	5 minute average of scattering coefficient (0 to 2000Mm^{-1} or user defined full scale).

3.5 Menus and screens

To enter the Main Menu from the Information Screen press **Enter** or **Select**. The main menu gives access to the following submenus.

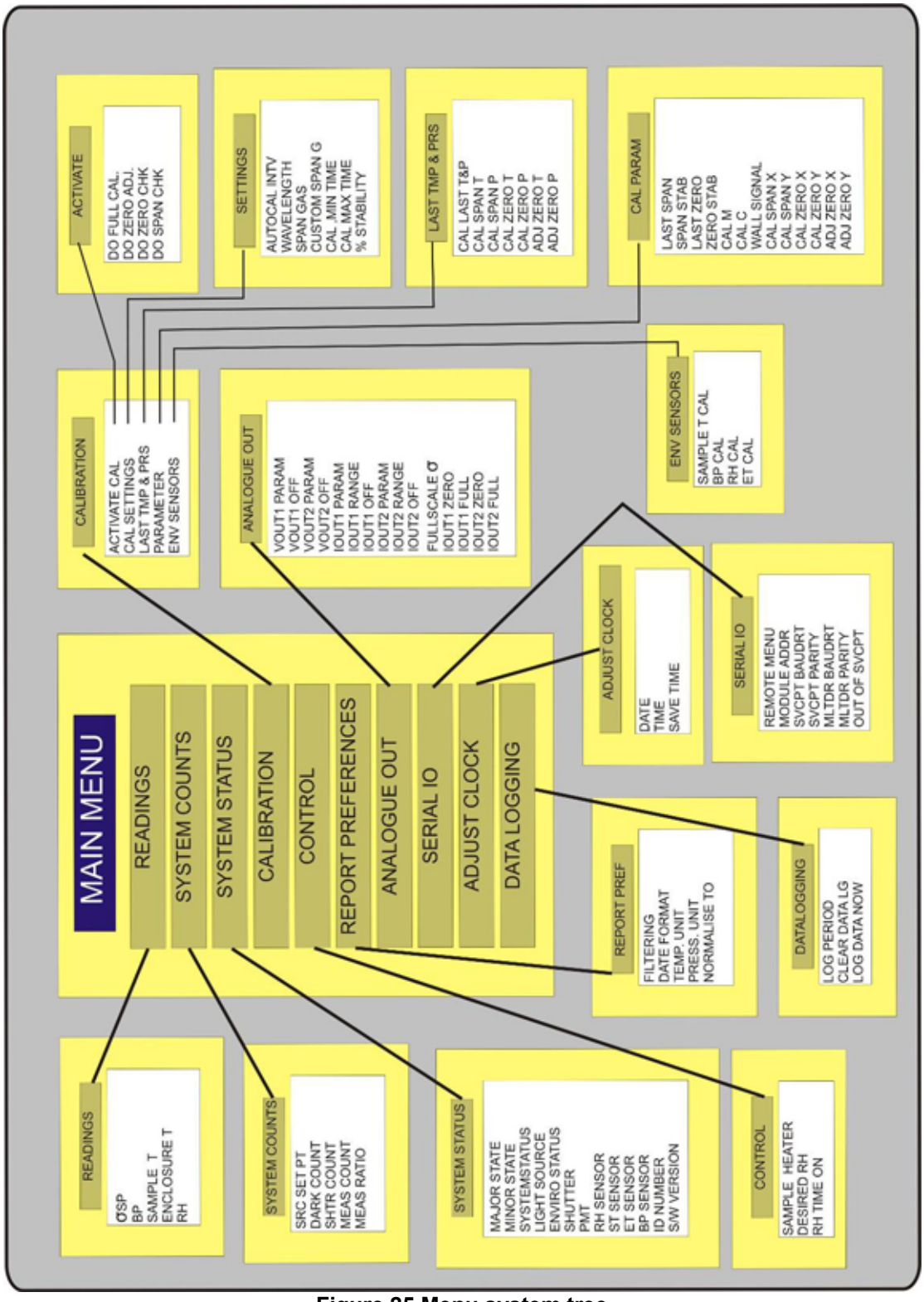


Figure 25 Menu system tree

3.5.1 Readings

The Readings Submenu displays the current environmental sensor readings. The σ_{sp} reading is updated more frequently than the other parameters.

σsp
Displays the current particulate scattering coefficient in Mm^{-1}.

BP
Displays the current air pressure inside the cell (mBar or atm).

Sample T
Displays the current sample air temperature inside the cell (^{o}C or ^{o}K)

Enclosure T
Displays the current cell temperature (^{o}C or ^{o}K).

RH
Displays the current sample air relative humidity (%).

3.5.2 System Counts

Src Set PT
The Source set point is a setting for the intensity of the light source. The higher this number is the more intense the light source is (factory set 15).

Dark Count
The measurement count taken when the light is off, used to offset incident light from reading. Should be 0 though 0-200 is typical (see section 1.4.2 for more details).

SHTR count
The shutter count take while the shutter is closed. This figure should be between 0.8M and 1.6M (see section 1.4.2 for more details).

Meas. Count
The measurement taken with light source on and shutter open. This figure will vary from 5k to 500k depending on particulate concentration (see section 1.4.2 for more details).

Meas. Ratio
The measure ratio is the ratio between the measure count and shutter count. (see section 1.4.2 for more details).

3.5.3 System Status

Major States

Monitr:	Normal monitoring mode
SysCal:	System calibration mode (During start-up or reset)
SpnCal:	Span calibration mode (During Full Calibration)
ZroCal:	Zero calibration mode (During Full Calibration)
ZroChk:	Zero check mode
SpnChk:	Span check mode
LeaChk:	Performing a leak check
ZroAdj:	Zero offset adjust (manual or automatic offset adjustment)

Minor states

Normal:	Normal Monitoring
ShtrDn:	Shutter moving into position and stabilizing
ShtrMs:	Shutter in place, taking shutter measurement
ShtrUp:	Shutter moving out of the way and stabilising

System Status
The System Status is the overall instruments status. If one status below fails then the system status will fail indicating that the entire system is not working.

Light Source
This status indicates whether the light source is working (pass/fail).

Enviro Status
The Enviro Status is the overall status of all the environmental sensors (RH Sensor, ST sensor, ET Sensor and BP Sensor). If one environmental sensor status fails then the Enviro Status will.

Shutter
This status indicates whether the shutter is working (pass/fail).

Photomultiplier
This status indicates whether the photomultiplier is working (pass/fail).

RH Sensor
This status indicates whether the Relative Humidity sensor is working (pass/fail).

ST Sensor
This status indicates whether the Sample Temperature sensor is working (pass/fail).

ET Sensor
This status indicates whether the Enclosure Temperature sensor is working (pass/fail).

BP Sensor
This status indicates whether the Pressure sensor is working (pass/fail).

ID Number
Lists the ID number of this unit

S/W Version

This menu item displays the version of software that the instrument is currently running. This is useful during some diagnostic and fault finding checks as well as for finding if an update to the software is required.

3.5.4 Calibration

The Calibration submenu has 5 submenus which cover all the aspects of calibration. These submenus allow the user to set the correct parameters to perform a calibration, initiate a calibration sequence and view the results from the previous calibration. For more information on performing calibrations, refer to section 4.

3.5.4.1 Activate Cal

Do full cal.
Performs a two point calibration using calibration gas and zero air. This sequence will adjust the calibration curve. The results are recorded as Last span ck & Last zero ck.

Do zero adj
Performs a zero adjustment on the instrument using zero air.
The results are recorded as Last zero adj.

Do zero chk.
Performs a check but no adjustment of the instrument's zero using zero air.
The results are recorded as Last zero ck.

Do span chk
Performs a check but no adjustment of instrument's span using calibration gas.
The results are recorded as Last span ck.

3.5.4.2 Cal Settings

AutoCal Intv
Sets the automatic calibration type (see next) repeat period: Hourly, 3hrs, 6hrs, 12hrs, 24hrs, Weekly on a designated day or Off .

Span gas
Sets the span gas to the type to be used during a full calibration: CO_2, SF6, FM-200, R-12, R 22, R-134 or Custom.

Custom SpanG
If the span gas type Custom is selected above, then the Rayleigh multiplier is entered here for the type of gas you are using (see Table 2).

Cal min time
Sets the minimum time (in minutes) that any span or zero adjustment or check may take.

Cal max time
Sets the maximum time (in minutes) that any span or zero adjustment or check may take.

% Stability
Sets the target stability for any span or zero adjustment or check.
Refer to sections 1.4.3 for further details.

3.5.4.3 Last TMP & PRS

Cal Span T
Displays the temperature during the last span calibration.

Cal Span P
Displays the pressure during the last e span calibration.

Cal Zero T
Displays the temperature during the last zero calibration.

Cal Zero P
Displays the pressure during the last zero calibration.

Adj Zero T
Displays the temperature during the last zero adjustment.

Adj Zero P
Displays the pressure during the last zero adjustment.

3.5.4.4 Cal PARAM

Last span
Displays the σ_{sp} value (in Mm^{-1}) obtained after a span check. If a full calibration is performed, it will display the σ_{sp} value before the span adjustment was made.

Span stab
Displays the % stability achieved during a span check or full calibration.

Last zero
Displays the σ_{sp} value (in Mm^{-1}) obtained after a zero check. If a zero adjust is performed, it will display the σ_{sp} value before the adjustment was made.

Zero stab
Displays the % stability achieved during a zero check or zero adjust.

Calibration M
Displays the gradient of the calibration line

Calibration C
Displays the intercept of the calibration line

Wall signal
Displays the calculated % of scattering as a result of wall scattering. This value is updated after a full calibration or zero adjust is completed. Refer to section 1.4.3 for more details.

Cal SPAN X

Displays the extinction coefficient at span calibration point

Cal SPAN Y
Displays the measurement ratio at span calibration point

Cal ZERO X
Displays the extinction coefficient at zero calibration point

Cal ZERO Y
Displays the measurement ratio at zero calibration point

Adj ZERO X
Displays the extinction coefficient at zero adjustment point

Adj ZERO Y
Displays the measurement ratio at zero adjustment point

3.5.4.5 Env Sensors

The Environmental sensors menu will display a screen:
* Warning * Changes will re-calibrate environmental sensors immediately.
By scrolling down you can find the four environmental sensors readings. To calibrate these sensors all that must be done is to enter in the correct value, the correct value must be obtained from a calibrated temperature, humidity or pressure sensor (see sections 4.4.1 and 4.4.2).

Sample T Cal
Displays the current temperature within the sample cell, field is editable.

BP Cal
Displays the current barometric pressure, field is editable.

RH Cal
Displays the current relative humidity, field is editable.

ET Cal
Displays the current temperature within the enclosure, field is editable

> **Note:** Do not change any of the above fields unless you are confident that the figure being entered is correct, inaccurate figures entered will result in faulty readings.

3.5.5 Control

The control submenu is where the user can set the sample heater properties. The configuration of this menu depends on which options are supplied and the application of the instrument.

Sample Heater
Sets the sample heater to either enabled (RH or XX°C) or disabled (No).

- If enabled (RH) the heater will maintain the sample air RH at a level less than that set in the Desired RH field (below).
- The heater can also be enabled by choosing a temperature at which the heater will maintain the sample at 0-50°C.
- If the sample heater is disabled then the sample air will not be heated.

Desired RH.
Sets the desired relative humidity range of the sample air: <40% (less than 40%), <50%,<60%,<70%,<80%,or <90%.

RH time on
Time in seconds that the sample heater is turned on for RH control.

3.5.6 Report Preferences

The Report preferences submenu allows the user to set the reporting preferences such as units and date format so that it is compatible with the local formats. These settings will alter the way the data is recorded in the internal data logger or via the RS232 interface.

Filtering
Sets the type of filtering used on the output data: Kalman (Adaptive digital filter, see section 2.3.1.5), MovAvg (fixed 30 second moving average filter) or None .

Date Format
Sets the date reporting format: D/M/Y, M/D/Y or Y-M-D (where D=Day, M=Month, Y=Year)

Temp.Unit
Sets the temperature unit: °C, °F or K
(degree Celsius, Fahrenheit or Kelvin)

Press.Unit
Sets the barometric pressure unit: mb or atm
(millibar or atmosphere)

Normalise to
Sets the standard temperature to which to normalise σ_{sp} readings: 25°C, 20°C, 0°C or None (do not normalise)

Temperature normalisation is used as follows:

- *European Union 20°C*
- *US EPA 25°C*
- *UK and Australia 0°C*

Ensure correct temperature is used as this will modify the data readings. Refer to section 1.4.3 for an example of how the readings can vary depending on the normalisation temperature.

3.5.7 Analogue Out

The Analogue Out submenu is where the user assigns parameters to each of the 4 analogue output ports on the External IO (25way) connector (Table 4). The range and analogue calibration parameters can also be set.

Vout 1 param
Sets the output parameters to be signalled on Voltage Out 1 (pin2).
Range is 0 – 5v. Parameters are σ_{sp}, ST, ET, RH, BP, Zero, Full, σ_{sp}5m.

Vout 1 off
Applies an offset to the voltage output. None (0%), 5% or 10%.

Vout 2 param
Sets the output parameters to be signalled on Voltage Out 2 (pin3).
Range is 0 – 5v. Parameters are σ_{sp}, ST, ET, RH, BP, Zero, Full, σ_{sp}5m.

Vout 2 off
Applies an offset to the voltage output. None (0%), 5% or 10%.

Iout 1 param
Sets the output parameters to be signalled on Current Out 1 (pin4). Parameters are σ_{sp}, ST, ET, RH, BP, Zero, Full, σ_{sp}5m.

Iout 1 range
Sets the output current range for Current out 1: 0-20mA or 4-20mA

Iout 1 off
Applies an offset to the current output. None (0%), 5% or 10%.

Iout 2 param
Sets the output parameters to be signalled on Current Out 2 (pin5). Parameters are σ_{sp}, ST, ET, RH, BP, Zero, Full, σ_{sp}5m.

Iout 2 range
Sets the output current range for Current out 2: 0-20mA or 4-20mA

Iout 2 off
Applies an offset to the current output. None (0%), 5% or 10%.

Full Scale σ
Sets the full scale range of the σ_{sp} parameter in M^{m-1} : 100, 200, 500, 1000, 2000 or 10000.

Iout1 Zero
Zero adjustment for Current Out 1. Units are in DAC counts. 8uA/count.

Iout1 Full
Full scale adjustment for Current Out 1. Units are in DAC counts. 8uA/count.

Iout2 Zero
Zero adjustment for Current Out 2. Units are in DAC counts. 8uA/count.

Iout2 Full
Full scale adjustment for Current Out 2. Units are in DAC counts. 8uA/count.

* The output parameters which can be signalled on these analogue output ports are:

For more information on setting up the analog outputs, refer to section 5.4.1.
Use Zero and Full are used to calibrate the Analogue outputs. They can also be used for calibrating your data logger.

3.5.8 Serial IO

The Serial IO submenu is where the user sets the parameters for the two RS232 serial ports (Multidrop and Service ports, Figure 18).

Remote Menu
When the remote menu is enabled, the user can access the menu system via the RS232 Service port using an ASCII terminal program. The user can navigate the menu remotely using the Up, Down, Left, Right arrow keys on the terminal.

Module Addr

Address for multidrop RS232 port: 0-7

SvcPt BaudRt
Communication Baud rate for service port: 1200 - 38400

SvcPt Parity
Parity setting for service port: None, Even, Odd

MltDr Baud Rt
Communication Baud rate for multidrop RS232 port: 1200 - 38400

MltDr Parity
Parity setting for multidrop RS232 port: None, Even, Odd

Out to SvcPt
Sends an unpolled data output string to the service port: None, 1 sec, 5 sec,
See section 5.1.4. 10 sec or 60 sec.

3.5.9 Adjust Clock

Note: When adjusting the clock ensure all data is downloaded before any changes are made.

To enter the current date and time: set the current date, the current time and remember to press enter on the Save time menu to have the date & time recorded.
A message "Setting clock…" will appear on the display and then return to the information screen.

Date	06/10/2007	Sets the current date
Time	11:02:09	Sets the current time
Save time	→	Records the date and time entered above

Note: Clear the data logger after changing time see section 3.5.10.

3.5.10 Data Logging

The data logging submenu allows the user to set the averaging period of the internal data logger as well as clearing the memory of the Aurora 1000.

Log period
Sets the data logging averaging period. 1min or 5 min.

Clear DataLg
Clears all data stored in the data logging memory

Log data now
Records instantaneous readings when enter is pressed

4 Calibration

Ecotech Aurora 1000 requires regular calibration against a known calibration source. The Aurora can perform 3 different calibrations of the measurement system:

- Precision Check (section 4.1)
- Full Calibration (section 4.2)
- Auto Calibration (section 4.3)

The Aurora also needs calibrations performed on various other sensors

- Pressure Calibration (section 4.4.1)
- Sample Temperature and Humidity Calibration (section 4.4.2)

Note: Before commencing any calibrations, make sure that the Aurora has been given 30 minutes to stabilise.

See section 6.2 for advice on calibration intervals

4.1 Precision Check

Precision checks should be performed on a regular basis (daily or weekly) using a calibration gas such as CO_2 (100% purity). The precision check is used to detect any drift in the instrument's calibration, it includes a span check and a zero check. Table 5 can be used to determine what action is required (if any) after the precision check.

Note: A precision check does not alter the calibration curve.

Table 5 Calibration check criteria.

Daily/Weekly Check	Calibration Tolerance	Action required
Zero Check	*±2 Mm^{-1}*	*Do zero adjust*
	±4Mm^{-1}	*Invalidate data* *Do zero adjust*
Span Check	*±1% of span point**	*Do full calibration*
	*±5% of span point**	*Invalidate data* *Do full calibration*

* If calibrating 525nm with FM200, ≈ 220 Mm^{-1} @ STP, then the ±5% limit would be ± 11 Mm^{-1}. The ±1% limit would be ± 2.2 Mm^{-1}.

4.1.1 Span check

The Span Check uses span gas to perform a span calibration on the Aurora without adjusting the calibration curve (only a comparison).
The Span check can be initiated as follows:

1. From the Calibration →Activate Cal submenu select the "Do span chk" .
2. The following message will appear "Span check will commence within 30 seconds"
3. The span valve will open. Make sure the calibration gas is connected and flowing.
4. The instrument will return to the main screen and display Cal Stability, & Cal Time.
5. The span check will continue until
   - Cal Time has passed the Cal min time (section 3.5.4.2)
   - & Cal Stability has exceeded the % Stability set in the settings submenu (section 3.5.4.2).
   - Or if % Stability has not been reached, then the span check will continue until the Cal max time has elapsed (section 3.5.4.2).
6. After the span check has finished, the Aurora will update the values for Last span ck and Span ck stab in the Cal Param submenu.

4.1.2 Zero check

The Zero Check uses internally filtered particle free air to perform a zero calibration check on the Aurora without adjusting the zero point (offset).
The zero check can be initiated as follows:

1. From the Calibration → Activate Cal submenu select the "Do zero chk" command.
2. The following message will appear "Zero check will commence within 30 seconds"
3. Next the zero pump will turn on and the instrument will return to the main screen and display Cal Stability & Cal Time.
4. The zero check will continue until
   - Cal Time has passed the Cal min time (section 3.5.4.2)
   - & Cal Stability has exceeded the % Stability set in the settings submenu (section 3.5.4.2).
   - Or if % Stability has not been reached, then the zero check will continue until the Cal max time has elapsed (section 3.5.4.2).
5. After the zero check has finished, the Aurora will update the values for Last zero ck and Zero ck stab in the Cal Param submenu.

4.2 Full Calibration

The full calibration performs a two-point calibration on the Aurora. The span point uses calibration gas, the zero point use internally filtered particle free air. A full calibration is one in which both the span and zero points on the calibration curve will be modified. Due to the high stability of the Aurora this type of calibration only needs to be performed approximately every 3 months using calibration gas. Typically FM200 is used for the full calibration. A full calibration can be performed as follows once the setup is completed:

4.2.1 Setup

Make sure that the following options in the Calibration submenu are set (see section 3.5.4) before commencing a calibration.

1. Span Gas type: Set to the type of calibration gas you are using. Generally CO_2 or FM200.
2. Cal min time. Set the minimum time (in minutes) required to complete each calibration step (span or zero). Typically set to 15 minutes for a good calibration.
3. Cal max time. Set to the maximum time (in minutes) required to complete each calibration step (span or zero). Typically set to 20 minutes for a good calibration.
4. % Stability. Set the target stability for the calibration. A value of about 95-97% is recommended. If after Cal min time the calibration has not reached the target stability then the calibration will continue until it reaches the target stability or Cal max time, which ever comes first. Refer to sections 1.4.3 for further details.
5. Make sure your Calibration Gas is connected correctly and the valves and regulators have been opened. Refer to section 2.2.1 for details on connecting the calibration gas to the Aurora.

> **Note:** Set the calibration gas flow rate to typically 3-4 lpm to calibrate the Aurora 1000.

4.2.2 Procedure

1. From the Calibration → Activate Cal submenu select the Do full cal command. Immediately the following message will appear on the display. "Full calibration will commence within 30 seconds" after this the span gas solenoid valve inside the Aurora will open and the Main screen will display the following parameters (alternating):

   Current σ_{sp}: 23.56
   The current σsp during the calibration.
   (based on the old calibration curve)

   Cal Stability: 97.50
   % Stability during the calibration.

   Meas Ratio: 0.0138
   The Measure Ratio during the calibration.

   Cal Time: 00:07:45
   The time the calibration has been running. (hh:mm:ss)

2. The span calibration portion of the full calibration sequence will end after:
    - Cal Time has passed the Cal min time (section 3.5.4.2)
    - & Cal Stability has exceeded the % Stability set in the settings submenu (section 3.5.4.2).
    - Or if % Stability has not been reached, then the zero check will
3. After the span calibration has finished, the Aurora will update the values for Last span and Span stab in the Calibration submenu as well as other vital calibration data. It will then automatically close the span gas solenoid valve and turn on the zero air pump ready for the zero calibration portion of the full calibration sequence.
4. The zero calibration will proceed the same as the span calibration. The information screen will display "ZroCal" as the major state. The bottom line will also display σ_{sp}, Cal Stability, Meas Ratio & Cal Time.
5. After the zero calibration has finished, the Aurora will update the values for Last zero and Zero stab in the Calibration submenu as well as other vital zero data. It will then turn off the zero air pump and turn on the sample pump ready for sample measuring.
6. After the sample measuring has commenced, the new calibration curve will be applied to the σ_{sp} readings.
7. Be sure to close the calibration gas cylinder after use to prevent any leaking.

4.2.3 Zero Adjust

The Zero Adjust performs a single point zero calibration on the Aurora. Using internally filtered particle free air, the zero adjust will adjust the zero calibration point (or offset) of the nephelometer. Although a zero calibration is calibrating against air rayleigh (15.4×10^{-6} m @ STP), the Aurora sets this point to zero (0) after the calibration. The zero adjust can be initiated as follows:

1. From the Calibration → Activate submenu select the Do zero adj command. Immediately the following message will appear on the display. "Zero adjustment will commence within 30 seconds" after this the zero pump will turn on and the information screen will be displayed.
2. In the same manner as the span calibration, the information screen will display σ_{sp}, Cal Stability, Meas Ratio & Cal Time.
3. The zero adjust will end after the Cal Time has passed the Cal min time and Cal Stability has exceeded the % Stability set in the calibration submenu. If the % Stability has not yet been reached, then the zero adjust will continue until the Cal max time has elapsed.
4. After the zero adjust has finished, the Aurora will update the values for last zero adj and zero stab in the Calibration → Parameters submenu as well as changing the zero offset on the calibration curve. It will then turn off the zero pump and turn on the sample pump ready for sample measuring.
5. After the sample measuring has commenced, the new calibration curve will be applied to the σ_{sp} readings.

4.3 Auto Calibration

The Aurora can be set to perform calibrations automatically at regular intervals. The check interval can be set in the Calibration submenu (Refer to section 3.5.4) under the AutoCal Intv parameter. The calibration can be set to calibrate: hourly, 3, 6, 12, 24hrs, on a specific day of the week or off. The Autocal Type can be set to: zero check, span check, zero & span check, or zero adjust (as discussed in section 4.1.1, 4.1.2 and 4.2.3).

4.4 Sensor Calibration

Equipment Required.

- Calibrated Temperature Probe.
- Calibrated Relative Humidity Sensor or Psychrometer.
- Calibrated Barometric Pressure Sensor.

4.4.1 Pressure Calibration

1. Disconnect the sample pump and allow the pressure reading to stabilize.
2. Disconnect the sample pump and allow the pressure reading to stabilize.
3. Obtain the current barometric pressure reading from a Calibrated Barometric Pressure Sensor (BPS).
4. Enter the Calibration → Env sensors menu, scroll down until BP Cal field.
5. Enter the Barometric pressure reading obtained with BPS into the field.
6. Reconnect the sample pump.

4.4.2 Sample Temperature and Humidity Calibration

1. Open the Aurora face by removing five screws from face edge
2. Remove the Vaisala Air Temperature sensor from the cell by first removing the cable (unscrew nut 1 anti-clockwise)
3. Release the sensor by unscrewing nut 2 (anti-clockwise) as shown below.

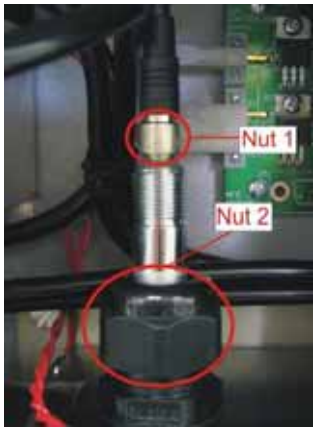


Figure 26 Temperature/Humidity sensor

4. Remove the sensor and allow the Aurora Air temp and Humidity readings to stabilise.

5. Place the calibrated Temperature Probe close to the Air Temperature Sensor and allow them to stabilise to ambient room temperature/humidity. Then take an ambient reading.
6. Record the Temperature and humidity
7. Enter the Calibration → Env sensors menu, scroll down and enter readings into their respective fields Temperature = Sample T Cal , Humidity = RH Cal.

Note: Perform span and zero calibration after environmental sensor calibration

4.5 Calibration via External IO/RS232

4.5.1 Initiating a Calibration via the External IO

The Aurora has a 25 pin External IO connector which is used, not only for connecting the analogue outputs, but also for connecting digital inputs. There are two designated digital inputs used for initiating the Zero and Span Measure modes. These inputs are ideally suited for external data logging devices which control the calibration sequences. There are no menu settings or software setup required to activate these inputs.

Activating Digital inputs

The external inputs for the span and zero measure control require a contact closure or open collector type of input as shown in Figure 26. The span or zero measure will commence once either of the two pins on the External IO connector are closed or activated low (connected to ground). Example is if a zero check is to be performed connecting the DOZERO (pin 7) to the ground would activate this.
The input signal must be:
Low (on) < 0.8V, or High (off) 2-5V
These pins have been labelled DOZERO and DOSPAN in Figure 26.

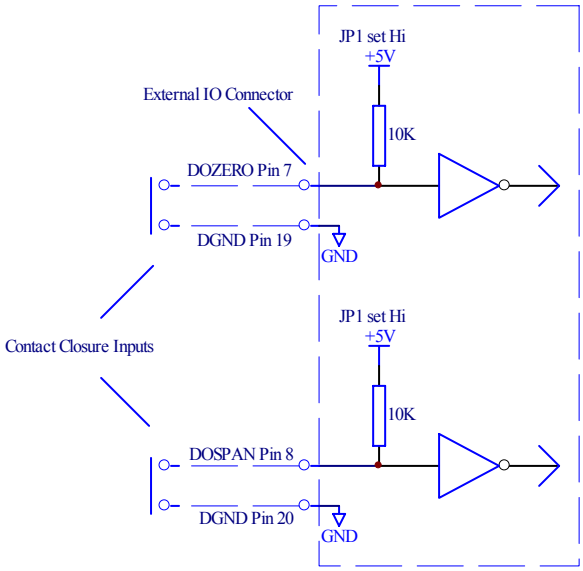


Figure 27 External Span & Zero Control

Zero Measure

The Zero Measure mode is activated using the DOZERO digital input.

1. As soon as the DOZERO input is activated the instrument will go into zero measure mode. The sample pump will turn off and the zero pump will turn on and zero valve will open, pumping particle free zero air into the measurement cell.
2. During the Zero Measure, the main screen will display “Zero Measure” on the top line.
3. The Zero Measure will continue for as long as the DOZERO input is activated. As soon as this input is de-activated, the Zero Measure will stop by turning off the zero pump, turning on the sample pump and switching of the zero valve. This procedure is only a check, no adjustment is made to the calibration curve.

Span Measure

The Span Measure mode is activated using the DOSPAN digital input.

1. As soon as the DOSPAN input is activated the instrument will go into Span measure mode. The sample pump will turn off and span gas solenoid valve will open, allowing calibration gas to pass into the measurement cell.
2. During the Span Measure, the main screen will display “Span Measure” on the top line.
3. The Span Measure will continue for as long as the DOSPAN input is activated. As soon as this input is de-activated, the Span Measure will stop by closing the span gas solenoid valve and turning on the sample pump. No adjustment is made to the calibration curve.

4.5.2 Initiating a Calibration via the RS232 Interface

The following commands can be used to initiate a calibration via the multidrop serial port: (The multidrop address is 0 in this example).

DO0001<CR> Sets the Aurora 1000 into span measure.

DO0000<CR> Sets the Aurora 1000 back to sample measure.

DO0011<CR> Sets the Aurora 1000 into zero measure.

DO0010<CR> Sets the Aurora 1000 back to sample measure.

Refer to Appendix A Aurora Command Set for more details on these commands and others.

4.6 Calibration Gases/Standards

4.6.1 Zero Air

The Aurora requires particle free air as its source of zero air. This is generated internally using the zero pump and a series of filters to remove all particulate matter. There is no need for any external connections to the zero air port. The zero point on the Aurora is also called Air Rayleigh which is equal to 15.4 x 10^{-6} m @ STP, however the measured σ_{sp} will read zero (0) at this point. All other measurements are made relative to Air Rayleigh.

4.6.2 Span Gas

The unique advantage of calibration (span) gases used in nephelometers is that they are stored in their liquefied form. Hence there is no need for expensive gas dilution systems. The calibration gas can be connected directly to the Aurora as specified in section 2.2.1. The other advantage is that each gas type has a unique σ_{sp} relative to Air Rayleigh. Hence the user when calibrating only has to select the correct span gas type and does not have to calculate dilution ratios and concentrations.
The Aurora supports CO_2, SF6, FM-200, R-12, R 22 and R-134 as the span gas types. See section 1.4.3 for further details on calibration gas constants for these gases. There is also the option of entering the Rayleigh multiplier of an unlisted calibration gas (or Custom Gas) in the calibration menu.
Ecotech use CO_2 and FM-200 when calibrating the Aurora in the factory. FM200 is a trade name and may also be known as Heptafluoropropane, CF_3CHFCF_3, HFC-227ea.
It is best to check with your local regulations and standards to see which calibration gas is to best used in your location.

4.6.3 Australian Calibration standard (AS3580.12.1:2.2001)

The Australian Standard AS3580 Method 12.1 for Determination of light scattering – Integrating nephelometer method, mentions the requirements for calibration frequency.
In section 8.3 of the standard, it mentions “A span calibration using FM200 shall be conducted at minimum intervals of no more than 3 months when the instrument uses an internal calibration flag”. It also mentions that the “calibration check shall be done daily or at least weekly using the internal calibration flag”.
The Aurora 1000 meets these requirements using its own internal reference shutter. The reference shutter is the same as the calibration flag in that it exhibits a known output each time it is switched into the optical path. The main advantage with the Aurora reference shutter is that it automatically makes the reference shutter measurement every 30 seconds.

5 Downloading data

There are three main ways of recording data from the Aurora 1000 which are mentioned in this manual. These are:

- Internal Data Logging Facility
- External Data Logging using RS232 interfaces
- External Data Logging using Analog Output interface

> **Note:** A laptop computer is a practical way of downloading the data from a Nephelometer that is in service in the field. If your laptop does not contain a serial port then a U.S.B. – serial adaptor should be used. It is highly recommended that the easysync U.S.B. – serial adaptor be used for this function as it has been widely tested with all Ecotech products, works effectively and can be purchased from Ecotech.

5.1 RS232 Interface

There are two RS232 interface connections available on the Aurora. They can be used for such things as downloading historical data, retrieving instantaneous readings or controlling certain features of the instrument. The following section will discuss the various functions of the Multidrop Port and the Service Port.

5.1.1 Multidrop Port

The multidrop serial port is the main port used for external data logging and control. This port responds to the majority of RS232 commands. The term multidrop is a term used to denote a parallel connection of multiple RS232 devices. All receivers share the same receive line that comes from a single master computer. Likewise, these multiple devices share the same transmit line which goes back to a single master computer. This method is ideal for attaching multiple instruments to a single master computer where the number of available serial ports are limited. All the instruments can be connected to a single multidrop cable. This type of configuration is often referred to as a daisy chain.
The integrity of this method relies on a number of important rules being followed:

- Each instrument in the multidrop must have a unique Module Address that is programmed into the unit before attaching to multidrop cable.
- After a command is sent by the master, the master must then wait for a response. Only after a reasonable time-out period should the master send another command.
- The multidrop master must include a time-out mechanism in the event that the Module Address sent with the command is garbled.
- The master must correlate the unit response with the Module Address sent in the command to know which unit in the multidrop is responding.
- Any command that would cause two units on the multidrop to respond at the same time must be avoided. If more than one unit attempts to respond on the common transmit line, a "data collision" will occur destroying both messages.

5.1.2 Service Port

The service serial port is not a multidrop port and will not respond to any multidrop commands. It is primarily used for remote menu operation and unpolled data output.

5.1.3 Establishing Communications

The first step in establishing communications with the Aurora-is to connect a computer or terminal to the Multidrop RS232 port. The default serial configuration for serial port is 9600,8,N,1 (9600 baud, 8 bits, no parity, and one stop bit). If you need to change the serial configuration from the default, use the Serial IO Submenu. Also make sure that the Module address is set to a unique value (the default is "0"). Once the instrument has been connected, use a communication package such as Hyper Terminal to establish communications with the instrument. Use one of the commands mentioned in Appendix A to test the communications.

5.1.4 Unpolled

The unpolled data output mode allows the Aurora to send a string of data out to the Service port only. The data is transmitted from the Aurora at regular interval without having to receive any commands from an external device such as a data logger. This is useful for capturing RS232 data if you don't have a data logging system. The data can be captured using a communications package such as HyperTerminal. The data output can only be enabled from the Serial IO menu in section 3.5.8. The output data interval can be set between 1 and 60 seconds. The unpolled data output on the service port does not interfere with the operation of the Multidrop port.
The format of the output data is the same as the response of the VI099 command and is documented in Appendix A Aurora Command Set.

5.1.5 Remote Control

The remote control feature of the Aurora allows the user to remotely operate the Aurora menu system using a RS232 terminal program such as HyperTerminal, which is connected directly to the Service port only.
It can be enabled in two ways:

- From the Remote Menu in section 3.5.8.
- From the Multidrop port using the **M command. See Appendix A Aurora Command Set.

The following key strokes can be used to navigate the remote menu system.

Table 6 Keypad Controls

Aurora 1000 Keypad	Terminal Equivalent
Enter	Enter
Select	Right Arrow Key
Page up	Left Arrow Key
*Exit	Q
Up arrow	Up Arrow Key
Down arrow	Down Arrow Key

Note: There may be a delay in returning to the main information screen as the remote terminal has to wait for the screen to be updated.

5.2 Internal Data Logging

5.2.1 Configuration

The internal Data Logging capabilities of the Aurora are very simple to operate. As long as the instrument is operating, the data logger is recording the data. The user has only to select the averaging period from the Data Logging menu (section 3.5.10). These are:

- 5 minutes, which allows up to 45days of data storage.
- 1 minute, which allows up to 10 days of data storage.

The data logger memory is cyclic, so that once it is full it will rewrite over the earliest data records. The memory is also battery backed so that data will not be lost when the power is off.

The data logger memory should be reset at the start of a sampling episode. When data is downloaded, it will only be taken from that time onwards.

The Log Data Now function allows the user to manually test the data logger by recording data instantaneously when the enter key is pressed.

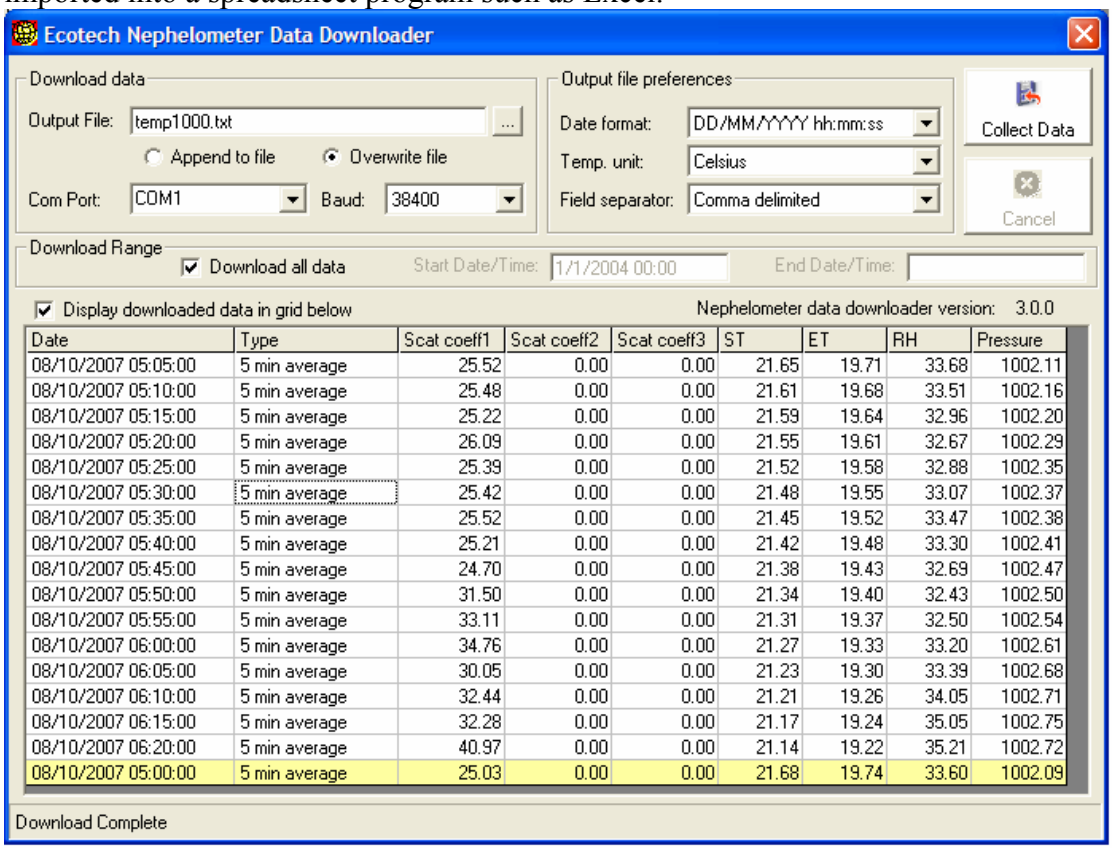
The parameters recorded in the data logger are as follows and cannot be changed:

Date Time, Averaging, σ_{sp} ($m10^{-6}$), Air Temp(°C), Cell Temp (°C), RH (%), Pressure (mbar)

e.g. 23/03/2004 12:30:00,5 min average,27.81,21.92,22.33,44.67,1009.77

5.2.2 Data Downloader Software

With the Aurora Data Downloader installed on your computer, the internal data logged by the Aurora can easily be downloaded to a text file where it can then be imported into a spreadsheet program such as Excel.



Date	Type	Scat coeff1	Scat coeff2	Scat coeff3	ST	ET	RH	Pressure
08/10/2007 05:05:00	5 min average	25.52	0.00	0.00	21.65	19.71	33.68	1002.11
08/10/2007 05:10:00	5 min average	25.48	0.00	0.00	21.61	19.68	33.51	1002.16
08/10/2007 05:15:00	5 min average	25.22	0.00	0.00	21.59	19.64	32.96	1002.20
08/10/2007 05:20:00	5 min average	26.09	0.00	0.00	21.55	19.61	32.67	1002.29
08/10/2007 05:25:00	5 min average	25.39	0.00	0.00	21.52	19.58	32.88	1002.35
08/10/2007 05:30:00	5 min average	25.42	0.00	0.00	21.48	19.55	33.07	1002.37
08/10/2007 05:35:00	5 min average	25.52	0.00	0.00	21.45	19.52	33.47	1002.38
08/10/2007 05:40:00	5 min average	25.21	0.00	0.00	21.42	19.48	33.30	1002.41
08/10/2007 05:45:00	5 min average	24.70	0.00	0.00	21.38	19.43	32.69	1002.47
08/10/2007 05:50:00	5 min average	31.50	0.00	0.00	21.34	19.40	32.43	1002.50
08/10/2007 05:55:00	5 min average	33.11	0.00	0.00	21.31	19.37	32.50	1002.54
08/10/2007 06:00:00	5 min average	34.76	0.00	0.00	21.27	19.33	33.20	1002.61
08/10/2007 06:05:00	5 min average	30.05	0.00	0.00	21.23	19.30	33.39	1002.68
08/10/2007 06:10:00	5 min average	32.44	0.00	0.00	21.21	19.26	34.05	1002.71
08/10/2007 06:15:00	5 min average	32.28	0.00	0.00	21.17	19.24	35.05	1002.75
08/10/2007 06:20:00	5 min average	40.97	0.00	0.00	21.14	19.22	35.21	1002.72
08/10/2007 05:00:00	5 min average	25.03	0.00	0.00	21.68	19.74	33.60	1002.09

Figure 28 Aurora Data Downloader

- Open the Aurora Data Downloader software where the following window is displayed as in Figure 27. The bottom left hand corner of the window displays the current status.
- Ensure that the Aurora is connected directly to your computer via the Multi-drop port and your computer's serial port.
- Enter in the "Output File" the name of the file you wish to save data to, and select whether you wish to overwrite or append to the file, if it already exists. Click the "…" button to browse for your output file. For importing into Excel, we recommend using the "txt" file extension for your output file.
- Select the appropriate Com port to be used by your computer.
- Set the Baud rate in the Data Downloader to match the setting on the Multi-Drop port on your Aurora ("Serial IO" menu).

  We strongly recommend using a baud rate of 38400 for fastest downloading speed.

- Select the appropriate Date Format, Temperature Unit and Field Separator. These settings will affect the format of the downloaded file. The Date Format is important if you're going to be importing the downloaded data into a spreadsheet such as Excel.

- Select either the “download all data” box or enter the start and end date for the period of data you wish to download.
- Select the box labelled “Display downloaded data in grid below” if you want to see the data as it is collected. For some computers, this option may slow down the data collection rate.
- When all is ready, click the “Collect Data” button. You will see the window below fill up with data. The data will also be saved to the file.
- When downloading is complete, you will be asked whether you wish to clear the data store. If you collect data periodically, it’s recommended that you clear the data each time, so you won’t have to download the same data over and over again.

Figure 29 clear the data store window

- If the Aurora is not connected or the serial IO settings are not correct, an error will be displayed when you try to collect data.

5.2.3 Importing Data into MS. Excel

- To import your data into Excel, run Excel and select File > Open. Then choose to open files of type “Text files”, and select your data file.

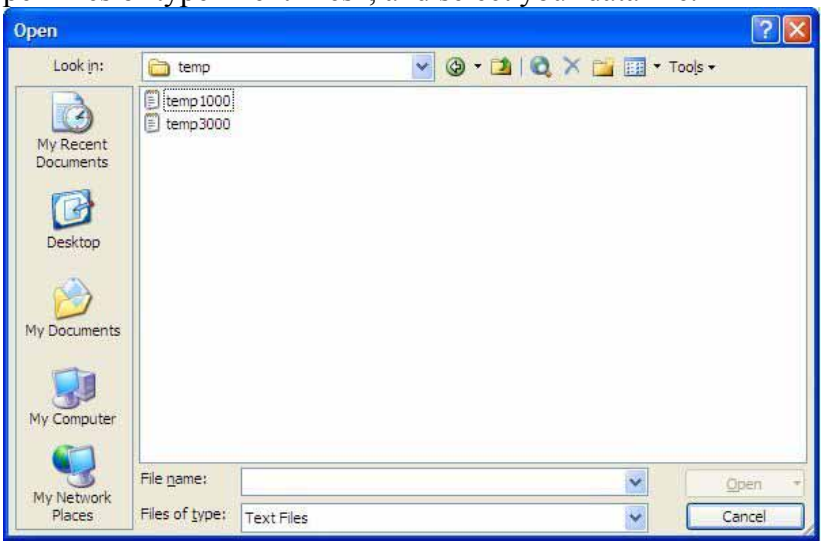


Figure 30 Open Window.

- The Text Import Wizard will appear.
- Set the settings to Delimited. Press the “Next” button.

Text Import Wizard - Step 1 of 3
The Text Wizard has determined that your data is Fixed Width.
If this is correct, choose Next, or choose the data type that best describes your data.
Original data type
Choose the file type that best describes your data:
Delimited - Characters such as commas or tabs separate each field.
Fixed width - Fields are aligned in columns with spaces between each field.
Start import at row: 1
File origin: 437 : OEM United States
Preview of file C:\Documents and Settings\elliottw\My Documents\temp\temp1000.txt.
1 07/10/2007 16:05:00,5 min average,3.17,0.00,0.00,29.31,27.29,17
2 07/10/2007 16:10:00,5 min average,3.10,0.00,0.00,29.28,27.26,17
3 07/10/2007 16:15:00,5 min average,3.02,0.00,0.00,29.27,27.23,17
4 07/10/2007 16:20:00,5 min average,3.16,0.00,0.00,29.24,27.20,18
5 07/10/2007 16:25:00,5 min average,3.36,0.00,0.00,29.21,27.18,17
Cancel
< Back
Next >
Finish

Figure 31 Step 1.

- Include Comma and Tab as the delimiters for the data.. Press the “Next” button.

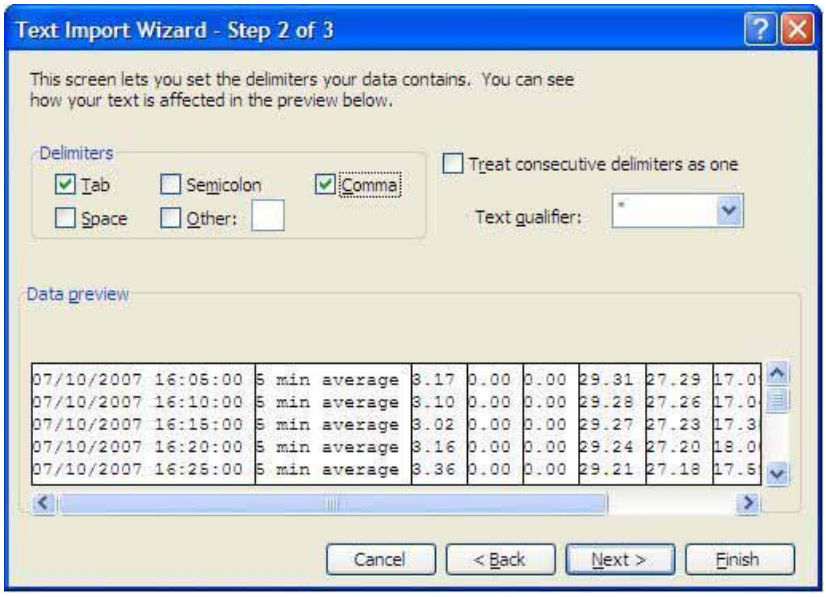

Text Import Wizard - Step 2 of 3
This screen lets you set the delimiters your data contains. You can see how your text is affected in the preview below.
Delimiters
Tab
Semicolon
Comma
Space
Other:
Treat consecutive delimiters as one
Text qualifier:
Data preview
07/10/2007 16:05:00 5 min average 3.17 0.00 0.00 29.31 27.29 17.0
07/10/2007 16:10:00 5 min average 3.10 0.00 0.00 29.28 27.26 17.0
07/10/2007 16:15:00 5 min average 3.02 0.00 0.00 29.27 27.23 17.3
07/10/2007 16:20:00 5 min average 3.16 0.00 0.00 29.24 27.20 18.0
07/10/2007 16:25:00 5 min average 3.36 0.00 0.00 29.21 27.18 17.5
Cancel
< Back
Next >
Finish

Figure 32 Step 2.

- Set the first row to Date format.
- Press the “Finish” button.

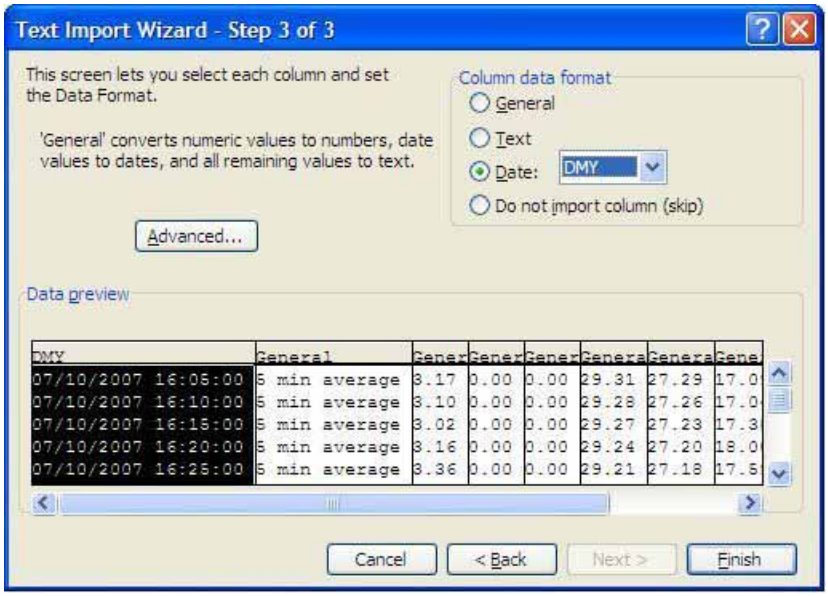

Text Import Wizard - Step 3 of 3
This screen lets you select each column and set the Data Format.
'General' converts numeric values to numbers, date values to dates, and all remaining values to text.
Advanced...
Column data format
General
Text
Date: DMY
Do not import column (skip)
Data preview
DMY General
07/10/2007 16:05:00 5 min average 3.17 0.00 0.00 29.31 27.29 17.0
07/10/2007 16:10:00 5 min average 3.10 0.00 0.00 29.28 27.26 17.0
07/10/2007 16:15:00 5 min average 3.02 0.00 0.00 29.27 27.23 17.3
07/10/2007 16:20:00 5 min average 3.16 0.00 0.00 29.24 27.20 18.0
07/10/2007 16:25:00 5 min average 3.36 0.00 0.00 29.21 27.18 17.5
Cancel
< Back
Next >
Finish

Figure 33 Step 3.

- Your data should be imported into Excel, as shown below in Figure 33.

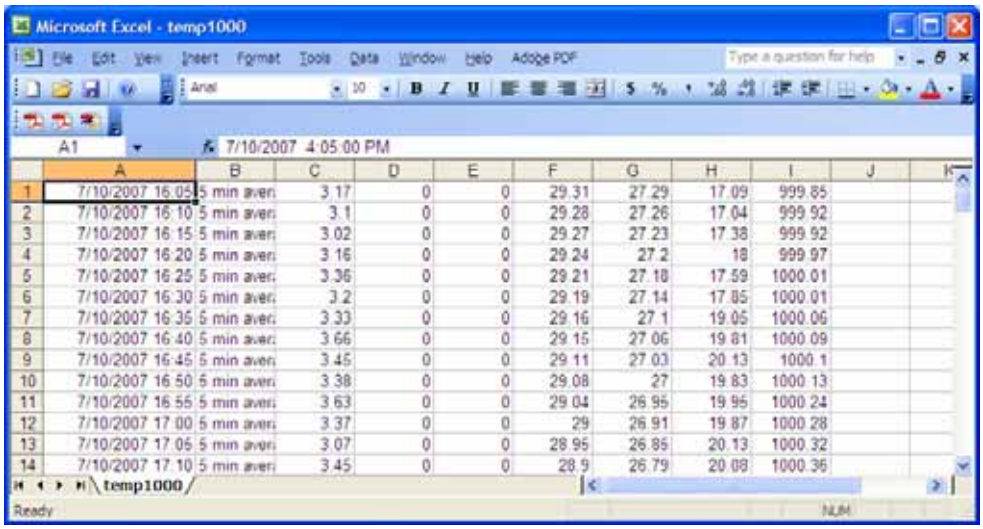


Figure 34 Imported Data.

- Note that if dates fail to import correctly, you may have to change your regional options. This can be done from the Control Panel > Regional Settings.

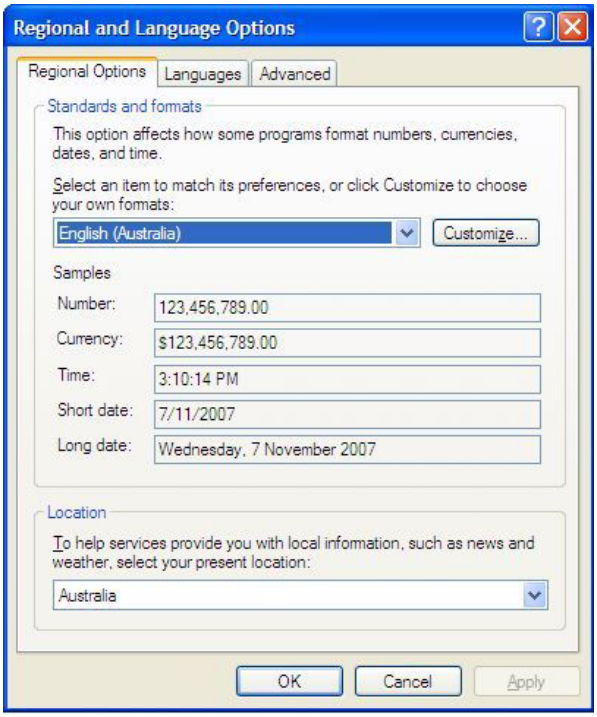


Figure 35 Regional Settings.

5.3 External Data Logging

There are a number of ways connecting the Aurora 1000 to an external data logger. The best way is by using the RS232 interface as there is no degradation in the transfer of data. The Ecotech AQMS & WinAQMS Data Acquisition Systems can be easily configured to log any of the Aurora parameters via RS232 Multidrop communications.

Using WinAQMS
For details on connecting the Aurora to the WinAQMS Data Acquisition System, please refer to the WinAQMS manual.

Using AQMS
For details on connecting the Aurora to the 9400 Data Acquisition System, please contact Ecotech for further details.

Unpolled data
For details on using an RS232 terminal program for capturing data from the Aurora, please refer to section 6.6.

Other Data Logging Software
If you are using some other data logging software for logging the Aurora 1000 then please refer carefully to the RS232 commands listed in Section 5 of this manual as to whether the software is compatible.

Ecotech takes no responsibility for data integrity when the Aurora is used with 3rd party software which does not meet the guidelines set out in Section 5.1 of this manual.

5.4 External Analog Data Logging

Another method of interfacing the Aurora 1000 to a data logger or chart recorder is by using the analog outputs. This is the next best option if there is no RS232 support.

5.4.1 Analogue output ports

The Aurora 1000 has 4 analog outputs. 2 x voltage and 2 x current outputs. These connections are found on the External I/O connector as shown in section 0.

- Vout1. Pin 2, 0 to 5V
- Vout2. Pin 3, 0 to 5V
- Iout1. Pin 4, 0 to 20mA or 4-20mA
- Iout2. Pin 5, 0 to 20mA or 4-20mA
- Ground. Pins 15, 16, 17, 18.

Any of the main parameters σ_{sp}, AirTemp, CelTemp, RH & Pressure can be assigned to any of these analog outputs. See section 2.2.3 for details on how to do this.
The following table lists some typical multipliers (M) and offsets (B) which would be used when programming your data logger or chart recorder.

Table 7 Analog Multiplier and Offsets

Parameter	Range	Voltage Output 0 – 5V		Current Output 0 – 20 mA		Current Output 4 – 20 mA	
		M	B	M	B	M	B
σ_{sp} *	0 – 2000 Mm^{-1}	400	0	100	0	125	-500
ST	-10°C to 60°C	20	-40	5	-40	6.25	-65
ET	-10°C to 60°C	20	-40	5	-40	6.25	-65
RH	0% to 98%	20	0	5	0	6.25	-25
BP	515 to 1115 mbar	120	+515	30	+515	37.55	+365
σ_{sp} 5m *	0 – 2000 Mm^{-1}	400	0	100	0	125	-500

*0-2000Mm-1 is default setting, user can specify any range they wish.

Zero and Full are used to calibrate the Analogue outputs. They can also be used for calibrating your data logger.
Each of the analog outputs can also be assigned an offset of 0%, 5% or 10% so that a floating zero can be used if the situation requires it.
Current outputs can be converted to voltage outputs by connecting a terminating resistor of value between 100 & 250 ohms between the output pin and the ground pin. The above multipliers would have to be recalculated to suit the terminating resistor used.

5.4.2 Analogue output Calibration

The voltage outputs mentioned above can not be calibrated. However the two current outputs can be. The following procedure explains how the I_{out} can be calibrated using a digital voltmeter (DVM). The same procedure applies if a data logger or chart recorder is connected.

1. Connect a calibrated DVM to the current output. The meter should be set to measure mA and connected in series with the output. If you have a terminating resistor on the I_{out}, then you can measure the voltage across the resistor.
2. In the Analog Output menu set the I_{out} 1 param to: Full. Set the I_{out} 1 range to: 4 –20 mA. . Set the I_{out} 1 off to: None. The DVM should read the full scale output of 20mA.
3. If this reading is high or low (eg. 20.15mA), then move down to the I_{out} 1 Full parameter and increase or decrease this number until the DVM reads 20mA exactly.
4. Then set the I_{out} 1 param to: Zero. The DVM should read the zero scale output of 4mA.
5. If this reading is high or low (eg. 4.05mA), then move down to the I_{out} 1 Zero parameter and increase or decrease this number until the DVM reads 4mA exactly.
6. Repeat steps 2 – 5 until the correct full scale and zero readings are obtained. Then set the I_{out} 1 param to the desired parameter for that channel and connect it to the data logger or chart recorder.
7. Verify that the data logger or chart recorder reading, correlate with what the Aurora is measuring.

The same procedure applies to the I_{out} 2 calibration.

5.5 Upgrading the Aurora 1000 Firmware

As improvements are made to the Aurora, these can be easily passed on to the user by updating the firmware (software operating within the Microprocessor board). To update the Aurora, you will need the Ecotech Firmware Updater Program. This is available on the Utilities CD supplied with your instrument or through the Ecotech website www.ecotech.com.au. Install this software on a Windows based computer with a COM port. Just follow the instructions on the installation screens to install this software.

The firmware file will have the ".sx" suffix. (eg. Aurora 2.10.SX). V2.10 refers to the version number. To check whether you have this version already installed on your instrument, check within the system status menu (section 3.5.3).

To update the firmware on the Aurora 1000:

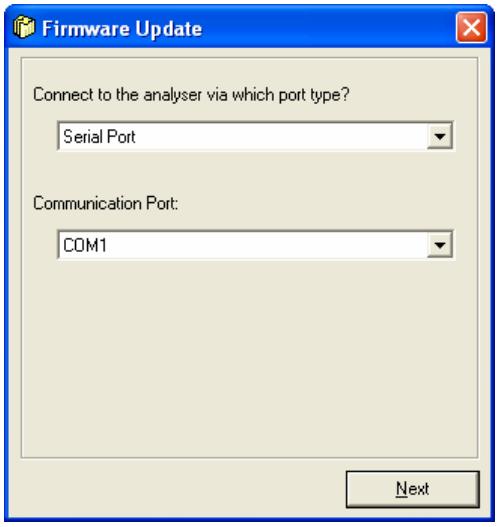


Figure 36 Communications Window.

1. Run 'Firmware Updater' from the 'Start - Programs - Ecotech - Firmware Updater' menu.
2. Connect the Aurora to the computer using a standard serial cable (you must connect directly to the Multidrop port).
3. Select 'Serial Port' and the COM Port on the computer from those listed on the Firmware Update screen as shown in Figure 35.
4. Press the Next Button to move to the next menu.

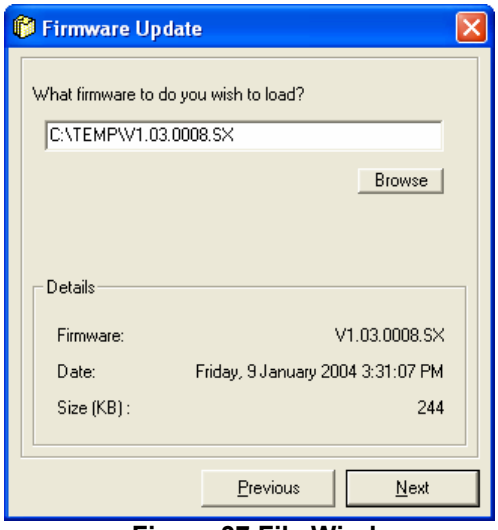


Figure 37 File Window.

5. Using the "Browse" button, locate the firmware file (.sx) which you wish to update the Aurora with.
6. Verify its details in the Details window as shown in Figure 36
7. Press the Next Button to move to the next menu.

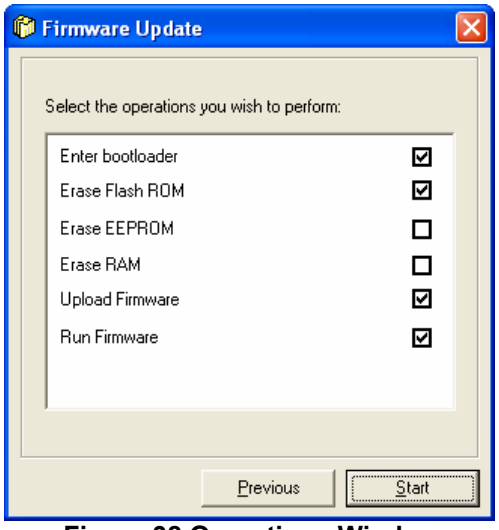


Figure 38 Operations Window.

8. Turn off the Aurora, and connect it directly to your computer via the Multi-Drop port and your computer's serial port. There is no need to change any baud rates.
9. Make sure that all the boxes as shown in Figure 37 are checked.
10. Press the "Start" button.

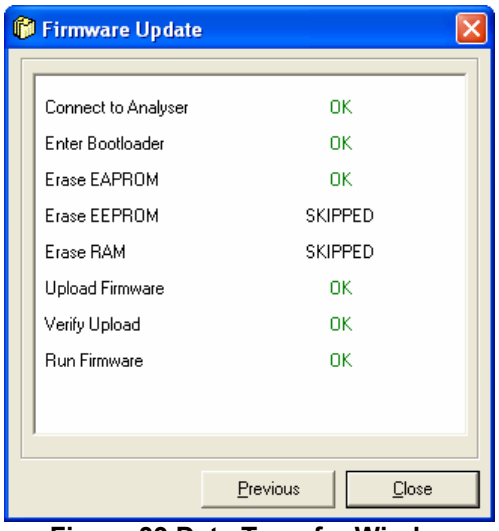


Figure 39 Data Transfer Window.

11. Turn on the Aurora 1000.
12. The Firmware Updater window will show each step as the firmware is uploaded. **DO NOT** turn the analyzer off until the 'Close' button is enabled as shown in Figure 38.
13. Your Aurora should now be running with the updated firmware. Confirm this.

After the firmware update, it is recommended that you do the following:

- Reset the Aurora by turning the power off then on again.
- Reconnect any cables that may have been removed to perform the update.
- Perform a full gas calibration.
- Clear the Aurora's data log.

The Aurora 1000 is now ready for use.

6 Maintenance

The following outlines a periodic maintenance schedule for the Aurora 1000. This schedule is based on experience under normal operating conditions, and may need to be modified to suit specific operating conditions. It is recommended that this schedule be followed in order to maintain reliable, long-term operation of the instrument.

6.1 Maintenance tools

To perform general maintenance on the Aurora, the user will be required to carry the following equipment:

Equipment Required.

- Phillips Head Screwdrivers.
- Flat ended Screwdriver.
- Adjustable wrench.
- Black cloth or plastic bag.
- Hex keys

Consumables

- Zero Air Pump inlet filter DFU (95%) pt: 036-040180
- Zero/Span Fine filter DFU (99.5%) pt: A-FIL-1050

6.2 Maintenance schedule

Table 8 Maintenance schedule

Interval *	Item	Procedure	Page
Weekly	Precision Check	Check	Section 6.3.1
Quarterly	Sample inlet & Bug trap	Inspect/Clean	Section 6.3.3
	Full Calibration	Perform	Section 4.2
	Clock	Check	Section 3.5.9
6 Months	Zero Pump Inlet Filter	Inspect/Replace	Section 6.3.4
	Zero / Span Fine Filter	Inspect/Replace	Section 6.3.5
	Measurement Cell	Clean	Section 6.3.2
Yearly	Leak Check	Perform	Section 6.3.6
	Batteries[1]	Replace	Section 6.3.7
	Measurement Chamber	Full clean	Section 6.3.10
	Pneumatics	Clean	Section 6.3.8
2 Years	Light Source[2]	Check/Calibrate	Contact Ecotech

* Suggested intervals for maintenance procedure may vary with sampling intensity and environmental conditions.

1. It is recommended that the backup batteries are disconnected if the Aurora 1000 is to be powered down for more than a few months. Save the logged data before you remove the old batteries as the data will be lost.

2. The intensity of the light source can be monitored by observing the LED count at start up. If it reaches 40, then the Aurora 1000 light source should be returned to Ecotech for re-calibration.

6.3 Maintenance procedures

6.3.1 Precision check

To ensure the instrument is running appropriately precision checks must be performed every week. A precision (calibration) check involves entering the Calibration menu and checking the Last zero ck field, Zero ck stab and Last span ck field.

1. The Last zero ck field should be 0 ±1 Mm^{-1}.
2. The Last span ck field should be within ±5% of span value.
3. The zero ck stab and span check stab fields should be above that entered into the stability field within the calibration menu

6.3.2 Measurement Cell cleaning

1. Turn off instrument
2. Undo the two screws located on the front panel of the instrument (1) and lower the Aurora front panel
3. Unscrew the 4 screws holding the light source in place (2)
4. Unplug the cable connected to the right side of the light source (3)

Note: Ensure that the O-ring within the light source is not lost or misplaced.

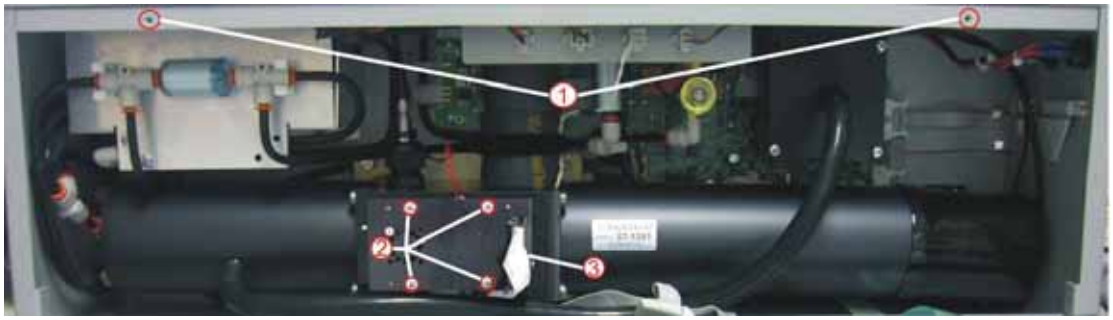


Figure 40 Aurora internal components

5. Use warm water on a lint free tissue to wipe the insides of the cell paying special attention to the bottom right section and the walls.

Note: Do not leave fingerprints or any residue within the cell

6. Leave the cell open until all internal surfaces are dry of water.
7. Replace light source, cables, earth and external cover to the instrument.

6.3.3 Sample inlet and bug trap clean

1. Remove the insect trap from the inlet.
2. Turn the two white handles so that they are not holding the central filter in place (see Figure 40).

Figure 41 Insect trap removal

3. Remove the central filter and clean both the inner and outer filters with warm water. Allow them to dry.
4. Place the inner filter back into the insect trap, return the handles to their original position and return the insect trap to the inlet.

6.3.4 Zero pump inlet filter

1. Open case
2. Remove DFU by opening quick fittings (Figure 41).
3. Replace with a new DFU 95% (pt: 036-040180)
4. Close case.

> **Note:** The 6 month interval is given as an indication only. More frequent filter replacements may be required depending on the instrument location.

6.3.5 Zero Span fine filter

1. Open case
2. Remove DFU by opening quick fittings (Figure 41).
3. Replace with a new DFU 99.5% (pt: A-FIL-1050)
4. Close case.

> **Note:** The 6 month interval is given as an indication only. More frequent filter replacements may be required depending on the instrument location.

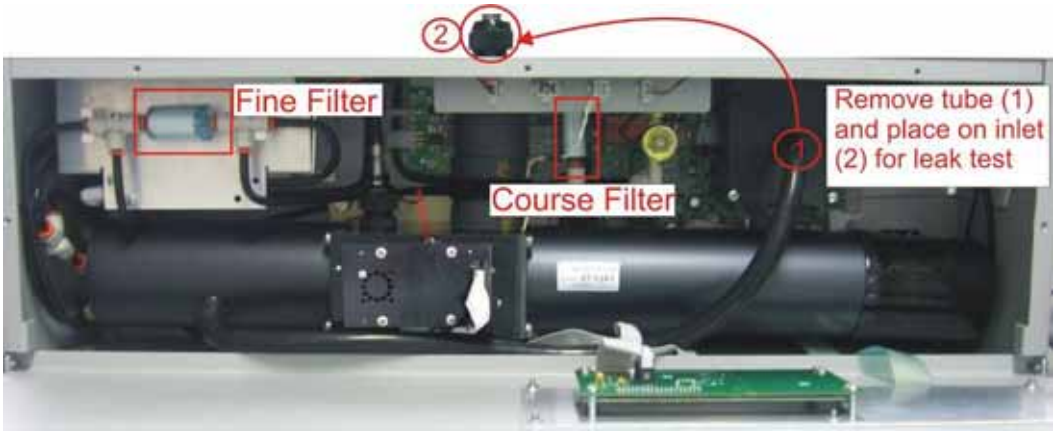


Figure 42 Aurora with Filters highlighted and leak test setup shown

6.3.6 Leak check

1. Should be performed earlier than scheduled if a high zero reading is observed. (greater than $1Mm^{-1}$).
2. Open case front (Section 6.3.2)
3. Remove sample tubing from main sample inlet.
4. Remove tubing from exhaust fan and place sample tubing on main sample inlet as shown in Figure 41.
5. Enter Leak check menu on main menu, screen will prompt you to connect the exhaust to the inlet, once this is done (step 4) change leak check field to yes and press enter.
6. Instrument will activate the zero pump and pressure will increase, wait as instrument checks for a slow leak.
7. If the screen gives the leak test a pass then there are no leaks and the tubes should be returned to normal.
8. If the leak test fails and “Low leak” is displayed then the tubing between the cell and sample inlet is either damaged or not plugged properly.
9. If the leak test fails and “Press.Leak” is displayed there is a leak within the cell (including tubing).

6.3.7 Battery replacement

Replace the two AA alkaline back-up batteries. This is best done with the power connected so that the clock and logged data are not lost.

> **Note:** It is recommended that the backup batteries are replaced if the Aurora is to be powered down for more than a few weeks. Save the logged data before you remove the old batteries as it will be lost.

6.3.8 Pneumatics cleaning

1. Remove power from the instrument
2. Open the case by removing the 5 external screws (as demonstrated in section 6.3.2)
3. Remove black tubing from the exhaust fan (1) and the measurement cell (2) as shown in Figure 42
4. Now remove the main sample inlet by removing the insulating foam (3) beneath it will be the main inlet tube secured via a nut to the main cell, unscrew this nut
5. Unscrew the nut on top of the instrument (4)
6. Remove the sample heater from its connector (5) and gently pull the main inlet up out through the top of the instrument
7. Clean both tubes in warm water (do not put main inlet under water, only clean inside of tube)
8. Leave to dry then replace all components back into instrument as they were found
9. Replace cover and run zero calibration

Figure 43 Internal pneumatic tubing

6.3.9 PMT Replacement

This procedure is for replacing the Photo Multiplier Tube (PMT) in the Aurora. This is not part of the routine maintenance and should only be performed on the advice of Ecotech engineers. It should only be performed by qualified Ecotech personnel or suitably trained field technicians. Please read through this procedure first before commencing any work.

CAUTION! This procedure involves handling light sensitive equipment. Make sure that all power is off at all times. Exposing the PMT to light when it is on will cause irreversible damage to the PMT. Exposure to strong ambient light can also cause short term instability. Be sure to keep the PMT covered at all times.

Removing PMT

1. Make sure that the power is off
2. Remove the front cover of the Aurora by unscrewing the 5 screws on the front panel (as shown in section 6.3.9).
3. Remove the cell from the instrument by first disconnecting all the cables/connectors below it as well as the ¼“ black tubing on the left.
4. Using the adjustable wrench, remove the sample inlet (see also step 4 section 6.3.8) and remove exhaust tubing.
5. Unscrew the four screws that are holding the measurement chamber to the nephelometer’s case.
6. Remove the black tubing connected to the left side of the cell then slowly move the left side of the cell out of the enclosure for access to the PMT
7. Carefully pull back the large black rubber cap on the right hand end of the cell. There are 2 cables and 1 black ¼ “ plastic tube penetrating this cap.

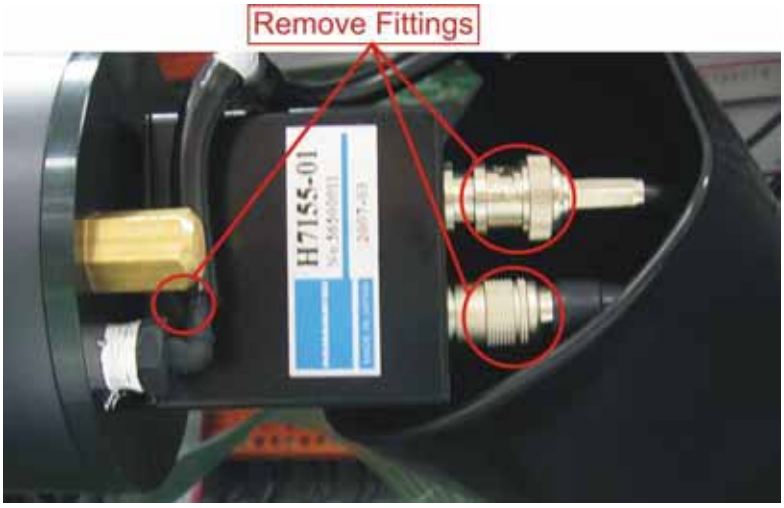


Figure 44 Removal of cell fittings

8. Remove the black tubing from the cell.
9. Disconnect the coaxial cable by rotating it anti-clockwise.
10. Remove the other smaller cable by pulling back the outer metal ring.
11. Now the PMT should be fully exposed.
12. The PMT is mounted on a bracket which is connected to the cell end-plate with two M4 screws. Before removing this bracket, make sure you have ready a black bag or cloth to put the PMT in. Also, between the PMT and the cell there is a small V groove o-ring which will fall out when the PMT is removed. Do not lose this o-ring.
13. Remove the PMT, O-ring and bracket and place in the black bag.
14. Now remove the PMT bracket from the PMT by unscrewing the 4 M3 screws. Each screw should have a spring washer, flat washer & white insulator. Please do not lose these.

Figure 45 Removing the PMT

15. Before removing the PMT completely, note the orientation of the PMT in relation to the cell and bracket.

Installing new PMT

16. Now take the new PMT from its box. Remove its protective black cover from its window and place it on the old PMT.

Figure 46 New PMT inserted

17. Then screw the new PMT onto the PMT bracket with the 4 M3 screws.
18. Attach the PMT bracket to the cell end plate and make sure the V groove O-ring is re-inserted flat and its sides are not twisted.
19. Re connect the 2 cables and push the black tubing in firmly.
20. Replace the black rubber cap making sure there are no gaps around the cell.
21. Double check all connections before turning the unit on.

Restarting the instrument

22. After turning on the power, observe how much the LED set point increases to get a shutter count of 1.2M.

23. When you are confident that everything is good, replace the front cover.
24. Allow the Aurora to warm up for at least 10 minutes, and then perform a Full Calibration.
25. After the calibration, verify that the ambient readings are realistic and stable.
26. Return the faulty PMT to Ecotech.

Procedure Completed.

6.3.10 Measurement Chamber Cleaning

1. Make sure that the power is off
2. Remove the front cover of the Aurora by unscrewing the 5 screws on the front panel (as shown in section 6.3.9).
3. Remove the cell from the instrument by first disconnecting all the cables/connectors below it as well as the ¼“ black tubing on the left.
4. Using the adjustable wrench, remove the sample inlet (see also step 4 section 6.3.8) and remove exhaust tubing.
5. Unscrew the four screws that are holding the measurement chamber to the nephelometer’s case.
6. Remove the black tubing connected to the left side of the cell then slowly move the left side of the cell out of the enclosure for access to the PMT
7. Carefully pull back the large black rubber cap on the right hand end of the cell. There are 2 cables and 1 black ¼ “ plastic tube penetrating this cap.

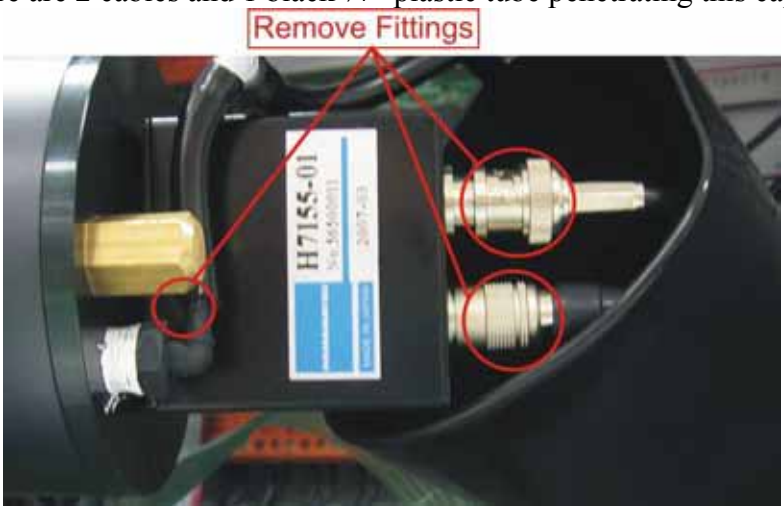


Figure 47 Removal of cell fittings

8. Remove the black tubing from the cell.
9. Disconnect the coaxial cable by rotating it anti-clockwise.
10. Remove the other smaller cable by pulling back the outer metal ring.
11. Now the PMT should be fully exposed.
12. The measurement chamber can now be removed carefully.
13. Remove the chamber cylinder on the right side (PMT side) by careful pulling it off. Ensure that the PMT’s exposure to light is minimised.
14. Clean shutter with lint free tissue and warm water and leave to dry. If baffles are also dirty clean them. Clean the O-ring if necessary; however avoid using O Ring grease.

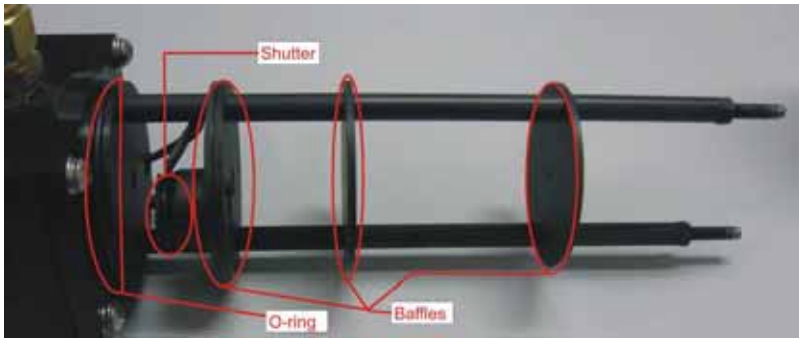


Figure 48 Measurement chamber right cylinder components

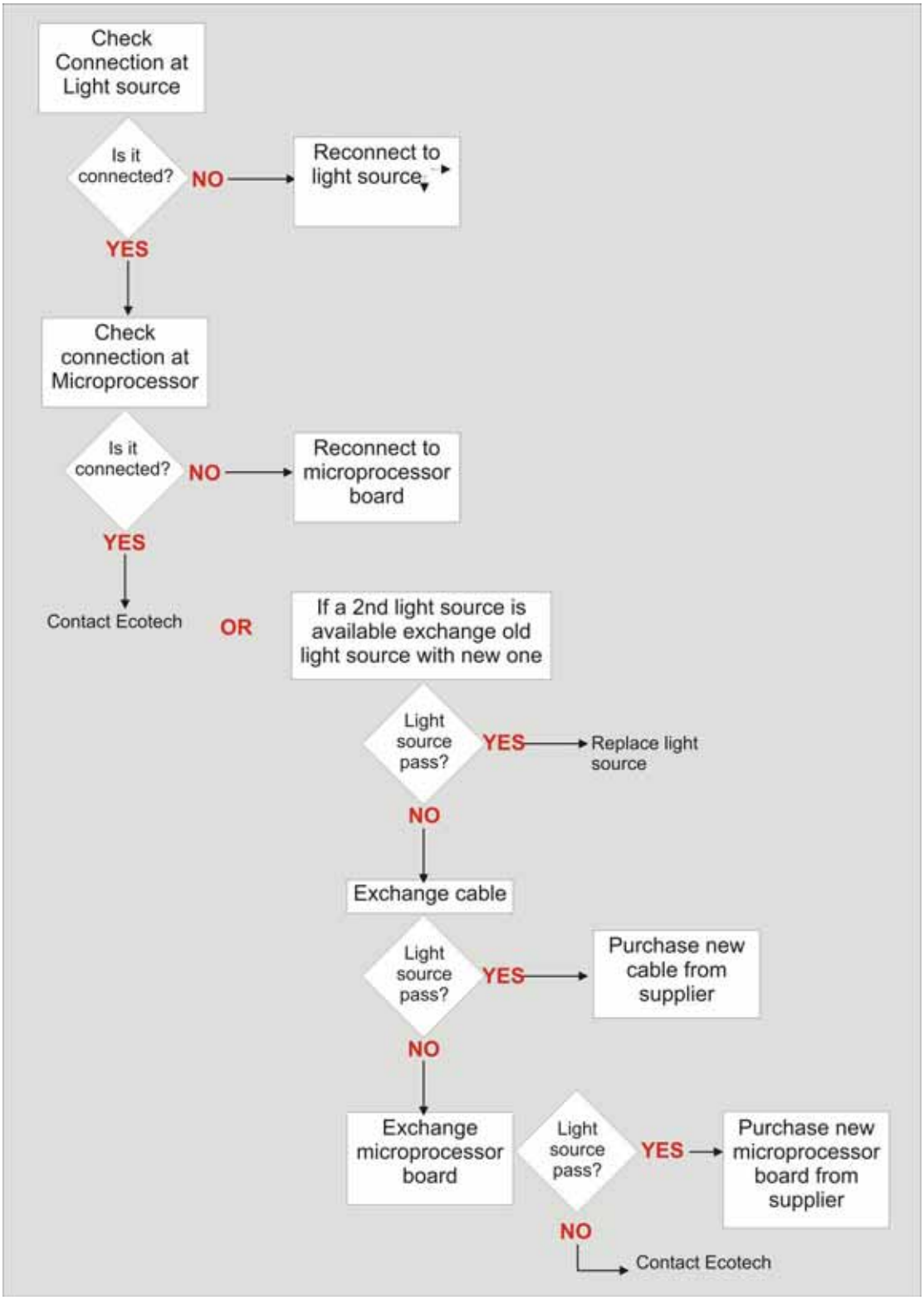
15. When this has been completed replace chamber cylinder.
16. Remove the end cap of the left side measurement chamber cylinder (light trap) by pulling it off and away from centre (may need some twisting).

Figure 49 Removing Light Trap

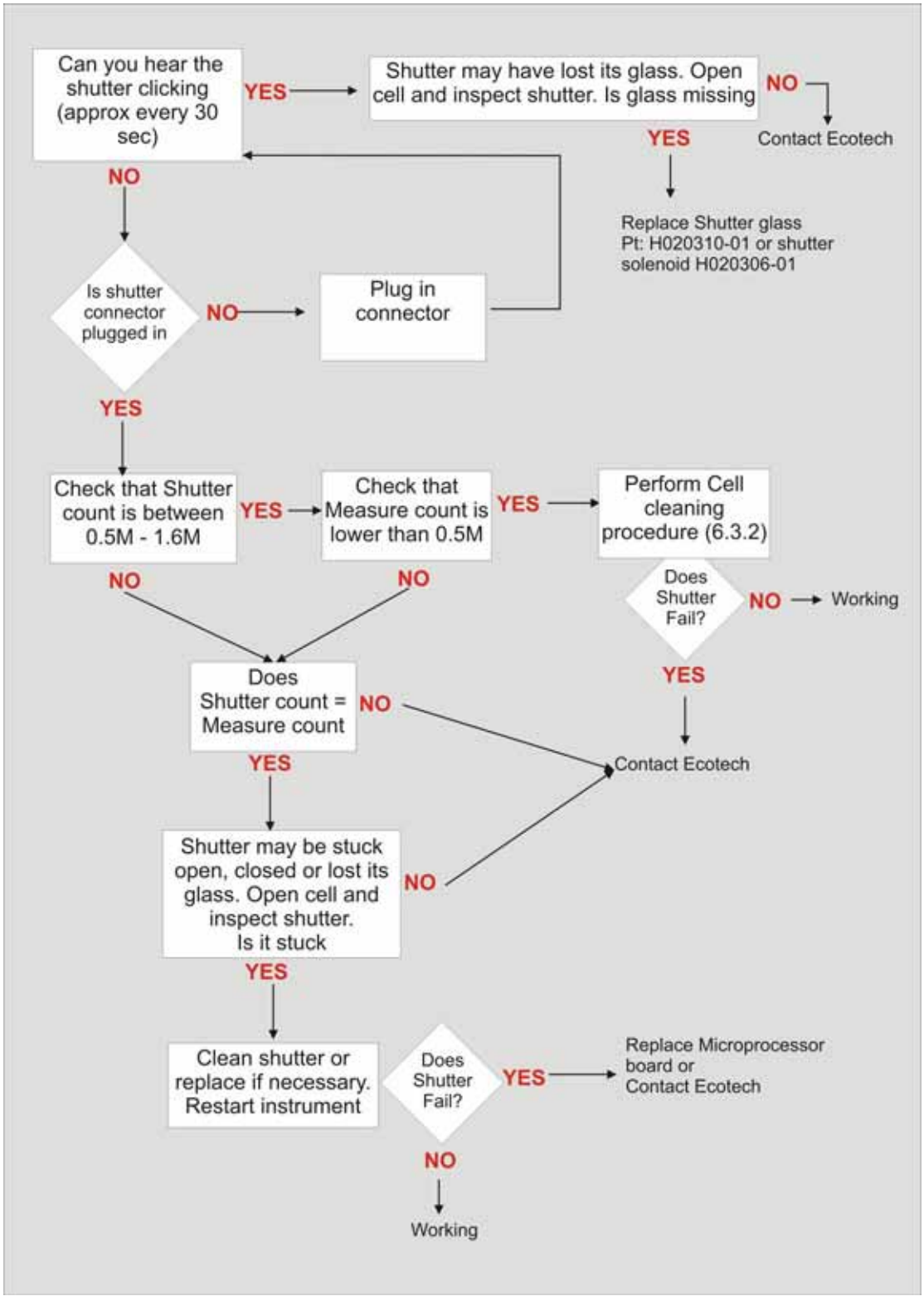
17. Clean light trap with a lint free tissue and warm water, leave to dry then replace back on the instrument. Clean the O-ring if necessary, however avoid using O-Ring grease.
18. Replace cell into instrument and replace all connections in reverse order to removal.
19. Perform a full calibration before normal operations can begin.

7 Troubleshooting

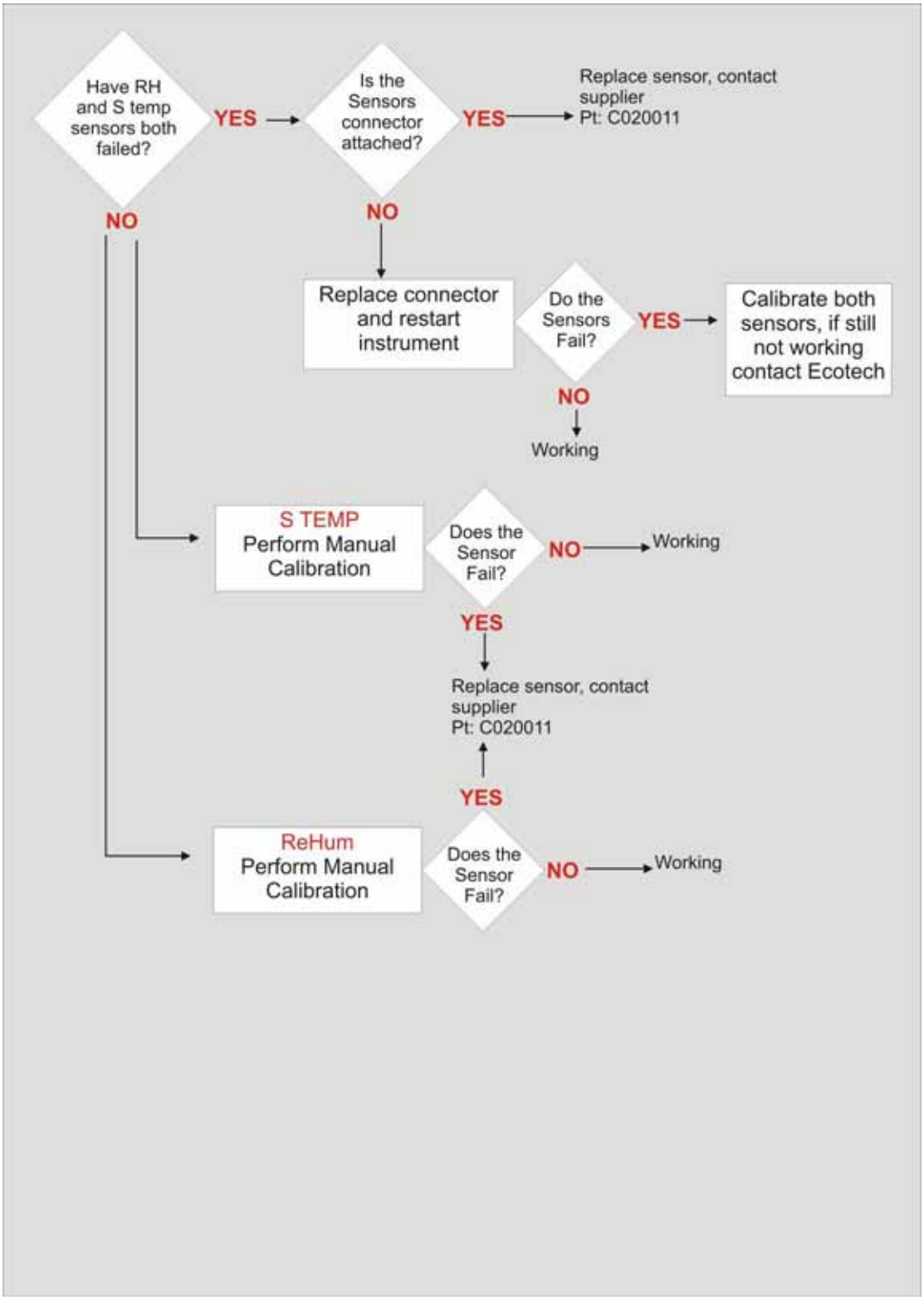
7.1 Lightsource Fail



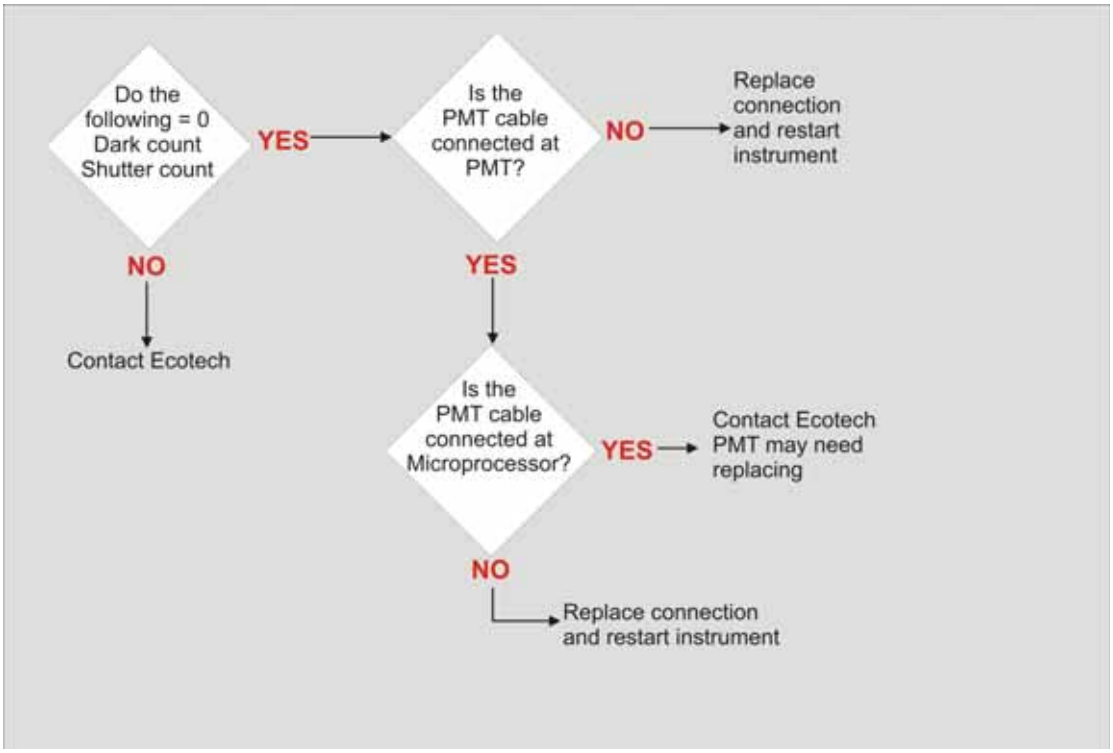
7.2 Shutter Fail



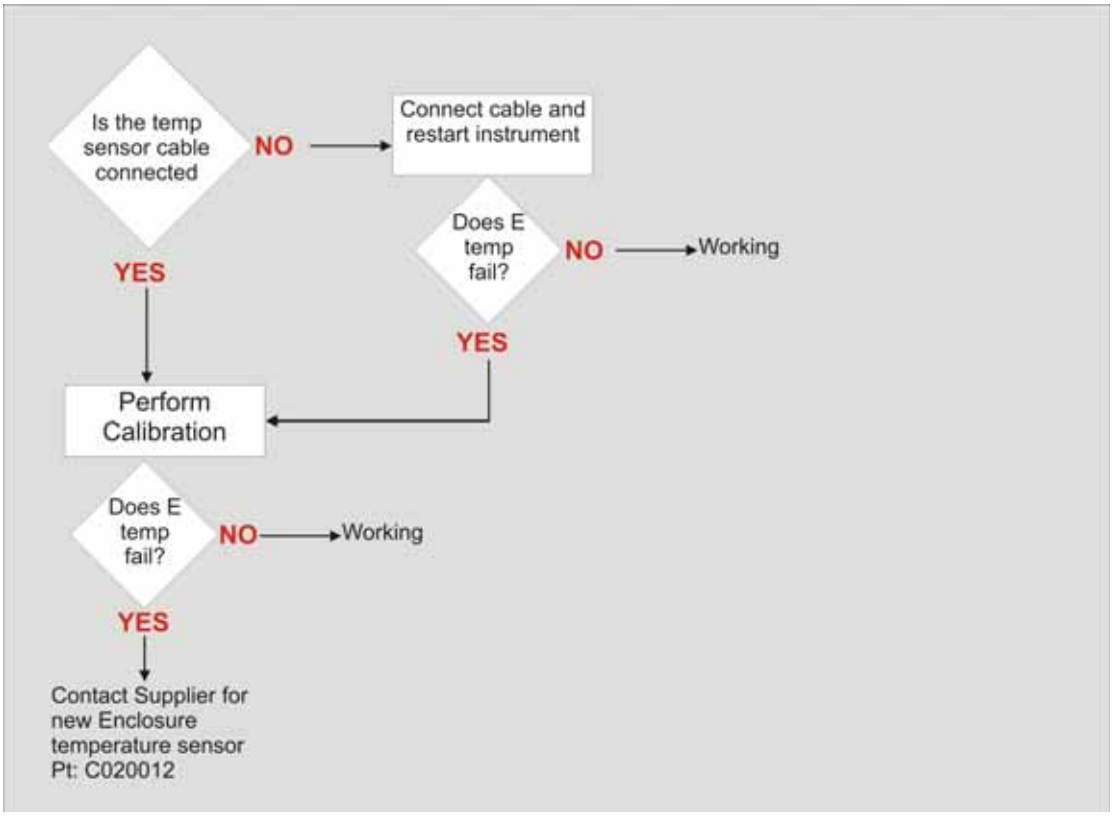
7.3 RH sensor & Temperature sensor fail



7.4 PMT Fail



7.5 Enclosure Temperature sensor Fail



Appendix A Aurora Command Set

Command: ID

Polls the Aurora 1000 for the instrument type, the current software/firmware version and the unique factory allocated identification number of the Nephelometer.

Syntax: `ID{<module address>}<cr>`

Response: `Ecotech Aurora 1000 Nephelometer v{<firmware version number>}, ID #{<instrument ID number>}<CR><LF>`

Example: `ID0<CR>` may respond with:
`Ecotech Aurora 1000 Nephelometer v2.00, ID #123456 <CR><LF>`

Related Commands: Pressing `CONTROL-T` also gives the same response.

Command: **PS

Programs the unique factory allocated identification number of the Nephelometer into memory. This number can be found in the bottom line of the main menu.

Syntax: `**{<module address>}PS{space}{<instrument ID number>}<CR>`

Response: `OK<CR><LF>`

Arguments: `<instrument ID>` is a six digit number allocated by Ecotech to each individual instrument.

Example: `**0PS_123456<CR>` responds with: `OK<CR><LF>` and sets the instrument ID number to 123456.

Command: **B

Re-Boot test. When initiated the Watchdog timer will be activated and cause the Aurora 1000 microprocessor to re-boot. The same as pressing the reset button on the microprocessor board.

Syntax: `**{<module address>}B<CR>`

Response: `null`

Example: `**0B<CR>` will re-boot the Aurora.

Command: **M

Enables / Disables the remote menu feature of the Aurora 1000. When enabled, the user can perform all menu operations remotely using a RS232 terminal connected to the Service port.

Syntax: `**{<module address>}M{<remote menu status>}<CR>`

Response: `OK<CR><LF>`

Arguments: `<remote menu status> = 1` turns the remote menu ON.

`<remote menu status> = 0` turns the remote menu OFF

Example: `**0M1<CR>` responds with: `OK<CR><LF>` and terns the remote menu on.

Command: **S

Sets the real-time clock on the Aurora 1000 microprocessor board. A single command can set the time and date.

Syntax: `**{<module address>}S{<hhmmssddMMyy>}<CR>`

Response: `OK<CR><LF>`

Arguments: `<hhmmssddMMyy>` is the current time and date. (hh) hour, (mm) minutes, (ss) seconds, (dd) day, (MM) Month, (yy) year.

Example: `**0S142536061003<CR>` responds with: `OK<CR><LF>` and sets the clock to: 14:25:36 on 6/10/2003.

Command: **PC

Programs the calibration parameters for the analog inputs and analog outputs. This is used mostly during factory calibration.

Syntax: `**{<module address>}PC{<calibration parameter>}{<calibration value>}<CR>`

Response: `OK<CR><LF>`

Arguments: `<calibration parameter> =` one of the following:

0. Calibration Pressure X point - pressure in kpa at calibration point.
1. Calibration Pressure Y point - A2D reading at calibration point.
2. Calibration thermistor factor - A2D reading of thermistor at 25 degrees.
3. Calibration Vaisala temperature offset - Vaisala temperature offset at minimum reading.
4. Calibration RH gradient - Vaisala RH gradient correction factor.
5. Calibration RH offset - Vaisala RH offset adjustment.
6. Analogue Output Current 1 Zero A/D point.

7. Analogue Output Current 1 Full A/D point.
8. Analogue Output Current 2 Zero A/D point.
9. Analogue Output Current 2 Full A/D point.

`<calibration value>` = an appropriate value to set each calibration point.

Example: `**0PC01013.25<CR>` responds with: `OK<CR><LF>` and programs the calibration pressure X point to 1013.25.

Command: **J

Forces or Jumps the Aurora program into one of the 8 major states. This is used mostly during factory testing.

Syntax: `**{<module address>}J{<major state number>}<CR>`

Response: `OK<CR><LF>`

Arguments: `<major state number>` = one of the following:

0. Normal Monitoring.
1. Span calibration (adjusts calibration curve).
2. Zero calibration (adjusts calibration curve).
3. Span check.
4. Zero check.
5. Zero offset adjust (adjusts calibration curve).
6. System calibration / startup.
7. Environmental calibration.

Example: `**0J6<CR>` responds with: `OK<CR><LF>` and forces the Aurora 1000 into system calibration (or start up).

Command: DO

Overrides the digital input & output control. Most commonly this command is used to force the Aurora 1000 into either span or zero measure mode.

Syntax: `DO{<module address>}{<digital parameter number>}{<digital parameter state>}<CR>`

Response: `OK<CR><LF>`

Arguments: `<digital parameter number>` = one of the following:

00. External DOSPAN control override.
01. External DOZERO control override.

02. Filtered air valve on/off (not used).

03. Output valve on/off (not used).

04. Digital out Aux control override.

05. Sample pump control override.

10. LCD backlight control override.

<digital parameter state> = 1 turns digital parameter ON.
<digital parameter state> = 0 turns digital parameter OFF.

Example: DO0001<CR> responds with: OK<CR><LF> and sets the AURORA 1000 into span measure.

Command: VI

Reads up to 100 different parameters from the Aurora 1000 microprocessor. Ideal for data logging devices which can poll the instrument for its data.

Syntax: VI{<module address>}{<voltage input parameter number>}<CR>

Response: {<sign>}{<parameter value>}<CR><LF>

Arguments: <sign> = <space> if positive, <-> if negative. (if the output is an ASCII character, then there is no <sign>.

<parameter value>= a value which can be either an ASCII character string, or a decimal number to six decimal places.

< voltage input parameter number > = one of the following:

See Note 1.

00. Scat coefficient . Mm^{-1}

01. Sample temperature. K

02. Relative humidity. %

03. Enclosure temperature. K

04. Atmospheric pressure. mBar

05. Dark count (moving average).

06. Shutter count (moving average).

07. Scat coefficient 5 minute average.

08. Measurement ratio (moving average).

09. Measurement ratio last reading.

10. Measurement photon count last reading .

11. Dark count last reading.

12. Shutter count last reading.

13. Atmospheric pressure 5 minute average. mBar

14. Air temperature 5 minute average. K

15. Cell temperature 5 minute average. K
16. Relative humidity 5 minute average. %
17. Air temperature in current reporting preference.
18. Cell temperature in current reporting preference.
19. Atmospheric pressure in current reporting reference.
20. Air temperature 5 minute average in current reporting preference.
21. Cell temperature 5 minute average in current reporting preference.
22. Atmospheric pressure 5 minute average in current reporting preference.
23. Shutter count sanity checking lower limit.
24. Shutter count sanity checking upper limit.
25. Calibration measurement count (moving average) - active only when a calibration is occurring.
26. Calibration measurement count last reading - active only when a calibration is occurring.
27. Calibration standard deviation - active only when a calibration is occurring.
28. Calibration stability - active only when a calibration is occurring.
29. <BLANK>
30. Calibration Pressure X point - pressure in mBar at calibration point.
30. Calibration Pressure Y point - A2D reading at calibration point.
32. Calibration thermistor factor - A2D reading of thermistor at 25 degrees C.
33. Calibration Vaisala temperature offset - Vaisala temperature offset at minimum reading. K
34. Calibration RH gradient - Vaisala RH gradient correction factor.
35. Calibration RH offset - Vaisala RH offset adjustment.
36. Calibration Gradient - gradient of calibration line.
37. Calibration offset - offset of calibration line.
38. Calibration wall scatter - wall scatter calculated from calibration gradient and offset. %
39. Kalman Filter Gain
40. Calibration Span X - extinction coefficient at span gas cal point.
41. Calibration Span Y - measurement ratio at span gas cal point.
42. Calibration Span temp - temperature at span gas cal point.
43. Calibration Span pressure - pressure at span gas cal point.
44. Calibration Zero X - extinction coefficient at zero air cal point.
45. Calibration Zero Y - measurement ratio at zero air cal point.

46. Calibration Zero temp - temperature at zero air cal point. K

47. Calibration Zero pressure - pressure at zero air cal point. mBar

48. Calibration Zero Adjust X - extinction coefficient at zero adjust cal point.

49. Calibration Zero Adjust Y - measurement ratio at zero adjust cal point.

50. Calibration Zero Adjust temp - temperature at zero adjust cal point. K

51. Calibration Zero Adjust pressure - pressure at zero adjust cal point. mBar

52. Analogue Output Current 1 Zero A/D point.

53. Analogue Output Current 1 Full A/D point.

54. Analogue Output Current 2 Zero A/D point.

55. Analogue Output Current 2 Full A/D point.

56. Calibration Span Check. Mm^{-1}.

57. Calibration Span Stability. %

58. Calibration Zero Check. Mm^{-1}.

59. Calibration Zero Stability. %

60. LED Wavelength setting (string).

61. Desired RH setting (string).

62. Normalise temperature setting (string).

63. Span gas setting (string).

64. Date format setting (string).

65. Temperature unit setting (string).

66. Atmospheric pressure unit setting (string).

67. Zero check frequency setting (string).

68. Major state (string).

69. Minor state (string).

70. LED Set position (string).

71. RS232 DO span/zero measure mode status. 016= span, 032= zero.

80. Clock date (in current report preference format) (string).

81. Clock time in hh:mm:ss format (string).

See Note 2. 90. Digital output status – PortD (string).

See Note 3. 99. Real time parameters obtained as one comma delimited string.

Example:

VI000<CR> responds with current bsp (Mm^{-1}) 26.3450<CR><LF>.
VI017<CR> responds with current air temp (°C) 22.529816<CR><LF>.
VI004<CR> responds with current pressure (mBar) 26.34<CR><LF>.
VI063<CR> responds with current span gas setting FM200<CR><LF>.

Note 1: Major State.

The VI000 command for reading the scattering coefficient is unique. It only has an output to 4 decimal places. The 4th digit after the decimal place denotes the major state which the instrument is in. The major state is represented by a number (0-7).

Syntax: VI{<module address>}00<CR>

Response: {<sign>}{<parameter value>}{<major state>}<CR><LF>

Arguments: <sign> = <space> if positive, <-> if negative.

<parameter value> = current bsp (Mm^{-1}) to 3 decimal places.

<major state> = one of the following:

0. Normal Monitoring.
1. Span calibration (adjusts calibration curve).
2. Zero calibration (adjusts calibration curve).
3. Span check.
4. Zero check.
5. Zero offset adjust (adjusts calibration curve).
6. System calibration / startup.
7. Environmental calibration.

Example: VI000<CR> responds with current bsp (Mm^{-1}) 26.3450<CR><LF>. Indicating that it is in Normal Monitoring state.
VI000<CR> responds with current bsp (Mm^{-1}) 26.3453<CR><LF>. Indicating that it is in Span Check state.

Note 2: Digital Output Status.

The VI090 command reads the Digital Output Status of the Aurora 1000 microprocessor board. The DIO status is the status of the digital outputs in hexadecimal. This enables you to determine exactly what the Aurora 1000 is doing. ie if in span or zero measure.

Syntax: VI{<module address>}90<CR>

Response: {<DIO state>}<CR><LF>

Arguments: <DIO state> = a hexadecimal number represented by the following:

00. Cell heater OFF
01. Inlet heater OFF

02. Sample pump ON

03. Zero pump ON

04. Span gas valve open

05. not used

06. not used

07. Digital aux out ON

Example: VI090<CR> responds with 07<CR><LF>.
Indicating: cell heater off, inlet heater off, sample pump on.
VI090<CR> responds with 0B<CR><LF>.
Indicating: cell heater off, inlet heater off, sample pump off, zero pump on. (zero measure).
VI090<CR> responds with 13<CR><LF>.
Indicating: cell heater off, inlet heater off, sample pump off, zero pump off, span valve open. (span measure).

Note 3: Single line output.

The VI099 command provides a unique output string. In one line it provides the time and date, scattering coefficient as well as the other meteorological parameters and current state information. The data is comma delimited.

Syntax: VI{<module address>}99<CR>

Response: {<date>},{<time>},{<scattering>},{<air temp>},{<cell temp>},{<RH>},{<pressure>},{<major state>},{<DIO state>}<CR><LF>

Arguments: <date> = Current date. Format as set in Report Preferences.

<time> = Current time. hh:mm:ss.

<scattering> = Current σsp in Mm^{-1}.

<air temp> = Current Air temp. Units as set in Report Preferences.

<cell temp> = Cell temp. Units as set in Report Preferences.

<RH> = Current Relative Humidity. Units in %.

<pressure> = Current Barometric Pressure. Units as set in Report Preferences.

<major state> = Major State as listed in Note 1. 2 digit number.

<DIO state> = DIO State as listed in Note 2.

<sign> = <space> if positive, <-> if negative.

Example: VI099<CR> responds with: 21/11/2003 09:45:27, 10.483, 22.108, 21.710, 41.370, 1000.436,00,07<CR><LF>.
Indicating that it is in Normal Monitoring state.
VI099<CR> responds with: 21/11/2003 09:56:10, -0.324, 22.894, 20.952, 40.671, 1000.642,04,0B<CR><LF>.
Indicating that it is in Zero Check state.